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ABSTRACT

The third of three volumes included in a secondary agricultural supplies and services curriculum guide, this volume contains twenty-five units of instruction in the area of agricultural mechanics. Among the unit topics included are (1) Farm Safety, (2) Ignition Systems, (3) Servicing Wheel Bearings, (4) Oxyacetylene Cutting, (5) Servicing the Tractor, (6) Fasteners, (7) Blueprint Reading, (8) Baler Operation and Maintenance, (9) Electrical Safety, (10) Fundamentals of Electricity, (11) Farm Fuels, and (12) Electrical Wiring Practices. Each unit follows a typical format which includes terminal objectives, specific objectives, suggested activities, instructional materials, references, information sheets, transparency masters, assignment sheets, tests, and test answers.
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AGRICULTURE

SUPPLIES & SERVICES

VOLUME 3 OF 3

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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AGRICULTURAL MECHANICS

1. Orientation and General Safety
2. Farm Safety
3. Figuring a Bill of Materials
4. Ignition System
5. Arc Welding
6. Servicing Wheel Bearings
7. Introduction to Oxyacetylene Cutting
8. Oxyacetylene Cutting
9. Servicing the Tractor--Cooling System
10. Servicing the Tractor--Air Supply System
11. Hydraulics
12. Fasteners
13. Metal Work
14. Blueprint Reading
15. Combine Operation and Maintenance
16. Baler Operation and Maintenance
17. Introduction to Plumbing
18. Electrical Safety
19. Servicing Small Engines
20. Fundamentals of Electricity
21. Engine Operation
22. Farm Fuels
23. Electric Motors
24. Electrical Wiring Practices
25. Repairing and Sharpening Tools Twist Drill

AGRICULTURAL
MECHANICS

ORIENTATION AND GENERAL SAFETY
UNIT I

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to define agricultural mechanics and list areas of study in an agricultural mechanics program. He should also be able to list occupations, identify tools, and list general safety precautions to observe in the shop. The knowledge will be evidenced by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define agricultural mechanics.
2. List two reasons why agricultural mechanics instruction is important to the agricultural industry.
3. Select from a list purposes for training in agricultural mechanical skills.
4. List ten steps in keeping a clean and orderly shop.
5. Match occupations in agricultural mechanics with the correct description.
6. List four purposes of the safety color code used in agricultural mechanics programs.
7. Discuss in a short paragraph, Kansas Law & Shop procedures regarding eye protection in the shop.
8. List steps to be taken involving accidents and first aid.
9. List three components of the fire triangle.
10. Match the four classes of fires with statements defining each class.
11. Match the types of fire extinguisher that is best suited to extinguish each class of fire.
12. Identify 30 common tools used in the agricultural mechanics shops.
13. Indicate a willingness to work safely by subscribing to the student safety pledge form.

ORIENTATION AND GENERAL SAFETY
UNIT I

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with objective sheet
2. Provide students with information sheet and safety pledge form
3. Make transparencies
4. Discuss terminal and specific objectives
5. Discuss information sheet
6. Give test

Student:

1. Read objective sheet
2. Study information sheet and take notes
3. Complete the safety pledge form
4. Take test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information Sheet
3. Transparency masters
 - TM 1--The Fire Triangle
 - TM 2--Types of Fire Extinguishers
 - TM 3--Common Tools
 - TM 4--Common Tools (Continued)
 - TM 5--Common Tools (Continued)
4. Assignment sheets
 - #1--Student Safety Pledge
 - #2--General Shop Safety Test
5. Answers to Assignment Sheet #2
6. Test
7. Answers to test

References:

1. Instructional Materials for Vocational Agriculture I. College Station, Texas: Teaching Materials Center, Agricultural Education Department, Texas A & M University.
2. Sneep, Neil O. Vocational Agriculture Training Programs: Safe Tractor Operation and Safe Farm Machinery Operation. East Lansing, Michigan: Rural Manpower Center, Michigan State University, 1969.
3. Schmidt, A.W., D.J. Witt, Loren Mills, and Charles Pearson "Safe Practices in the Vocational Agriculture Shop." Urbana, Illinois: Teachers of Vocational Agriculture, State Of Illinois.
4. Test Materials Handout and Job Sheets, prepared by the Agricultural Engineering 4220 class, Summer, Professor George Cook. Stillwater, Oklahoma: Oklahoma State University, 1963.
5. Williams, William A. Accident Prevention Manual for Shop Teachers. Chicago, Illinois: American Technical Society, 1963.
6. Best's Safety Directory. Morriston, New Jersey: A.M. Best Co., 1968.
7. Ross, Henry and R.N. Craig, Modern Farm Shop. -Austin, Texas: Steck-Vaughn Co., 1954.
8. A Guide for Course Planning in Introduction to Agriculture. Raleigh, North Carolina: Division of Vocational Education, Agricultural Education Section, Department of Public Instruction.
9. Hollenberg, A.H. How To Teach Arc Welding in Farm Mechanics. Columbus, Ohio: The James F. Lincoln Arc Welding Foundation, 1958.
10. Hoover, Norman K. Handbook of Agriculture Occupation. Danville Illinois: Interstate Printers and Publishers, 1963.
11. Phipps, Lloyd J. Mechanics in Agriculture. Danville, Illinois: Interstate Printers and Publishers, Inc., 1970.

ORIENTATION AND GENERAL SAFETY
UNIT I

INFORMATION SHEET

- I. Agricultural mechanics--All the unspecialized mechanical activities performed on the farm and in the home including instruction in the following areas:
- A. Agricultural shopwork
(NOTE: This includes selection, sharpening, care and correct use of shop tools and equipment; woodwork and simple carpentry; sheet metal work; elementary forge work; electric arc and oxyacetylene welding; pipe fitting; simple plumbing repairs; and rope work.)
 - B. Agricultural power and machinery
(NOTE: This includes selection, management, adjustment, operation, maintenance, and repair (excluding major repair requiring specialized equipment and service) of gas engines, trucks, and tractors and principle machines used in farming and agriculturally oriented business and services.)
 - C. Rural electrification
(NOTE: This includes utilization of electricity in the home and in productive enterprises and selection, installation, operation, and maintenance of electrical equipment.)
 - D. Agricultural buildings and conveniences
(NOTE: This includes elementary scale drawing and plan reading; farmstead layout; functional requirements of houses, shelters, and storages; water systems; and septic tanks and sewage disposals.)
 - E. Soil and water amnagement
(NOTE: This includes elementary leveling; land measurement and mapping; drainage; irrigation; terracing; contouring; and strip cropping.)
- II. Importance of agricultural mechanics instruction to the agricultural industry
- A. Most of the work involves some type of machanical activity
 - B. Approximately 85% of machinery in operation is out of adjustment
 - C. Must be able to service and maintain all the equipment used

IX. Components of the fire triangle (Transparency 1)

- A. Fuel--Any combustible material
- B. Oxygen--Necessary to sustain combustion
- C. Heat--Enough to raise the fuel to its ignition temperature

(NOTE: To produce fire these three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started or with the removal of any one of them, the fire will be extinguished.)

X. Classes of fires

- A. Class A--Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish
- B. Class B--Fires that occur with flammable liquids, such as gasoline, oil, grease, paints and thinners
- C. Class C--Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring
- D. Class D--Fires that occur with combustible metals, such as magnesium.

XI. Types of fire extinguishers (Transparency 2)

- A. Pressurized water--Operates usually by squeezing a handle or trigger; used on Class A fires
- B. Soda acid--Operates by turning extinguisher upside down; used on Class A fires
- C. Carbon dioxide (CO_2)--Operates usually by squeezing a handle or a trigger; used on Class B and C fires
- D. Dry chemical--Operates usually by squeezing a handle, a trigger, or lever; used on Class B, C, and D fires
- E. Foam--Operates by turning extinguisher upside down; used on Class A and B fires

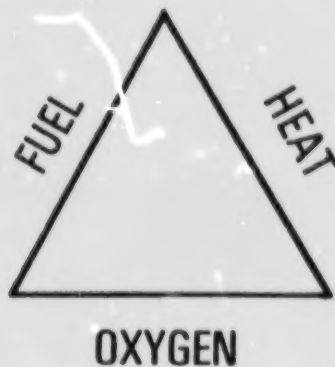
XII. Common tools used in agricultural mechanics shops (Transparencies 3,4, & 5)

- A. Dividers
- B. Inside calipers
- C. Outside calipers
- D. Welder's chipping hammer
- E. Burr reamer
- F. Hand drill
- G. Adjustable hacksaw

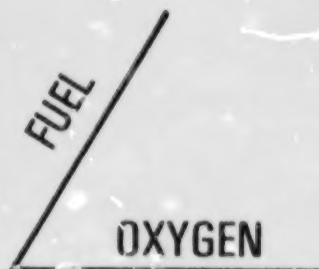
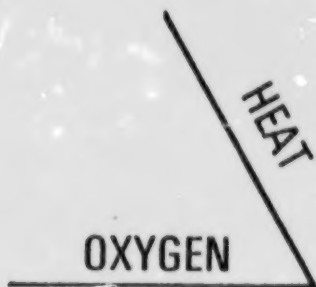
H. Jack plane
I. Carpenter's brace
J. Ripsaw
K. Wire brush
L. Crosscut
M. Ripsaw teeth
N. Machinest's vise
O. Adjustable wrench
P. Slip-joint pliers
Q. Bolt cutter
R. Combination wrench
S. Ball-peen hammer
T. Soldering copper
U. Open-end wrench
V. Standard screwdriver
W. Carpenter's level
X. Wood chisel
Y. Steel-framing square
Z. Vise-grip pliers
AA. Wrecking bar
BB. Pipe wrench
CC. Tinner's snips
DD. Combination square
EE. Pipe cutter
FF. Steel tape
GG. Tap wrench
HH. Allen wrench
II. Diestock
JJ. Curved claw hammer
KK. Flat file
LL. C-clamp
MM. Folding rule
NN. Round file
OO. Phillips screwdriver

The Fire Triangle

To produce fire, three things must be present at the same time.



If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.



Types of Fire Extinguishers



**Pressurized
Water**



Soda-Acid



**Carbon
Dioxide**

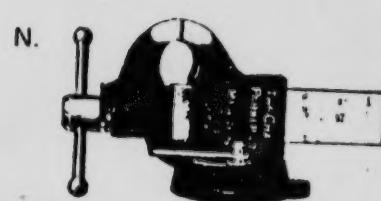
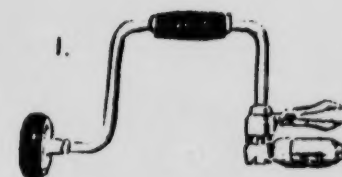
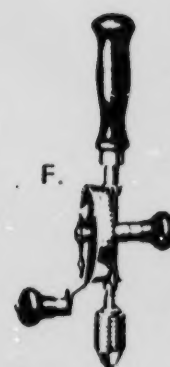
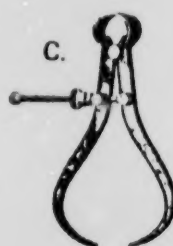


**Dry
Chemical**



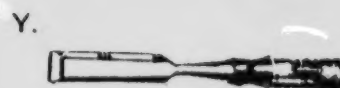
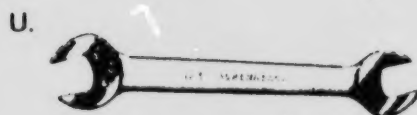
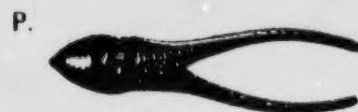
Foam

Common Tools



Common Tools

(Continued)



Common Tools

(Continued)

EE.



FF.



GG.



HH.



II.



JJ.



KK.



LL.



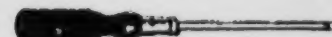
MM.



NN.



OO.



ORIENTATION AND GENERAL SAFETY
UNIT I

ASSIGNMENT SHEET #1--STUDENT SAFETY PLEDGE

1. I pledge myself to follow all rules and regulations pertaining to the safety of myself and others.
2. I will constantly watch for any unsafe acts, practices, or conditions that might reduce the safety of myself or others.
3. I will report all unsafe acts, practices, or conditions to my teacher immediately.
4. I will do my job in a safe and orderly manner, so that I will not endanger the safety of myself or others.
5. I will report all injuries, no matter how slight, to the first aid department immediately.
6. I will keep my work place in a safe and orderly condition at all times.
7. I will promote and respectfully solicit the cooperation of all pupils in safety and good housekeeping.
8. I will bear in mind at all times that my job will be safe only as long as I make it safe.
9. I will never lose sight of the fact that accidents do not just happen, they are caused.
10. I will do these things with respect and mutual understanding in all my relations with my fellow pupils, because only in this way can I feel sure that I am doing everything within my power to make my room and my school a safer and better place in which to work.

ASSIGNMENT SHEET #1

SAFETY-PRACTICE FORM

_____ HIGH SCHOOL

_____, who is enrolled in a vocational _____ course, will, as a part of his shop experience, operate machines, providing that his parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it himself.

The student must assume responsibility for the following safe practices, and we therefore ask that he subscribe to the following safety pledge:

1. I promise to follow all safety rules for the shop.
2. I promise never to use a machine without first having permission from the teacher.
3. I will not ask permission to use a particular machine unless I have been instructed in it's use and have made 100% on the safety test given on that machine.
4. I will report any accident or injury to the teacher immediately.

Date _____ Student's Signature _____

I hereby give my consent to allow my son to operate all machines and equipment necessary in carrying out the requirements of the course in which he is enrolled.

Date _____ Parent's Signature _____

Parents are cordially invited to visit the shops to inspect the machines and to see them in operation at any time.

ORIENTATION AND GENERAL SAFETY
UNIT I

ASSIGNMENT SHEET #2--GENERAL SHOP SAFETY TEST

Answer the following by circling "T" if true and "F" if false.

- T F 1. You should always learn the right way to do a job.
- T F 2. Always work at a fast speed.
- T F 3. Report all injuries to instructor.
- T F 4. Observe all warning signs and tags.
- T F 5. Unless you have been taught to operate a machine, stay away from it.
- T F 6. Never attempt to make an adjustment or clear a jam while a machine is running.
- T F 7. Guards may be left off some machines.
- T F 8. It is permissible to leave a machine running while not in use.
- T F 9. Remove chuck wrenches from chucks immediately after wrench is used.
- T F 10. Use only tools and equipment in good condition.
- T F 11. Equip files with handles before using them.
- T F 12. Always use the proper tool for the job.
- T F 13. In lifting an object, be sure you have a good footing then jerk the object.
- T F 14. Wear goggles when there is a chance of getting foreign material in your eyes.
- T F 15. When working on or near machinery, do not wear worn or ragged clothing.
- T F 16. Before using a hammer, check the trademark.
- T F 17. When chiseling metal, wear goggles and caution nearby students against sparks.
- T F 18. To avoid flying metal chips, never use a chisel with a mushroom head.
- T F 19. When using a cold chisel on an empty barrel, the barrell should be filled with air.
- T F 20. Always put out the torch when it becomes necessary to readjust the work.

- T F 21. Never use more than 15 psi of acetylene pressure.
- T F 22. Always handle hot metal with gloves.
- T F 23. Open cylinder valves quickly.
- T F 24. Never use oil on oxyacetylene regulators.
- T F 25. Never use oxygen as a substitute for compressed air.
- T F 26. Release adjusting screw on oxygen regulator before opening cylinder valve.
- T F 27. To light the oxyacetylene torch, use a match.
- T F 28. It is permissible to adjust the arc welding machine while it is running.
- T F 29. When striking an arc always say "cover."
- T F 30. Do not use worn or frayed cables when running a welding machine.
- T F 31. First aid stations are marked with a red cross.
- T F 32. "Horseplay" should never occur in the shop.
- T F 33. Always have good ventilation when working.

Student's Signature

ORIENTATION AND GENERAL SAFETY
UNIT I

TEST

1. Define agricultural mechanics.

2. List two reasons why agricultural mechanics instruction is important to the agricultural industry.
 - a.
 - b.

3. Select from the list below purposes for training in agricultural mechanic skills. Place an "X" in front of the statement that is correct.
 - ☐ a. Aids students to continue their education
 - ☐ b. Aids students in discovering mechanical aptitudes
 - ☐ c. Prepares students for entry into job opportunities after high school
 - ☐ d. Train students in basic skills needed on the farm and for related agricultural industries
 - ☐ e. Prepares students for college entry

4. List ten steps in keeping a clean and orderly shop.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.
 - g.
 - h.
 - i.
 - j.

5. Match occupations in agricultural mechanics with the correct description.

- | | |
|---|---------------------------------|
| _____ a. Operates farm equipment as a farm employee | 1. Welder |
| _____ b. Assists mechanic and is in training to become a mechanic | 2. Farm Machinery Operator |
| _____ c. Works with dealership selling farm machinery and equipment | 3. Mechanic |
| _____ d. Repairs and builds equipment | 4. Mechanic's Helper |
| _____ e. Repairs and overhauls engines, hydraulic systems, electric systems, etc. | 5. Farm Machinery Parts Manager |
| _____ f. Handles parts and repairs in machinery dealership | 6. Farm Machinery Salesman |
| _____ g. Assists farmers with problems in operating their equipment | 7. Farm Machinery Fieldman |

6. List four purposes of the safety color code used in agricultural mechanics programs.

- a.
- b.
- c.
- d.

7. Discuss in a short paragraph Kansas Law and Shop Procedures regarding eye protection in the shop.

8. List step to be taken involving accidents and first aid.

- a. Accidents
- b. First Aid
 - 1.
 - 2.
 - 3.

9. List three components of the fire triangle.

- a.
- b.
- c.

10. Match the classes of fire with the correct statement defining each class.

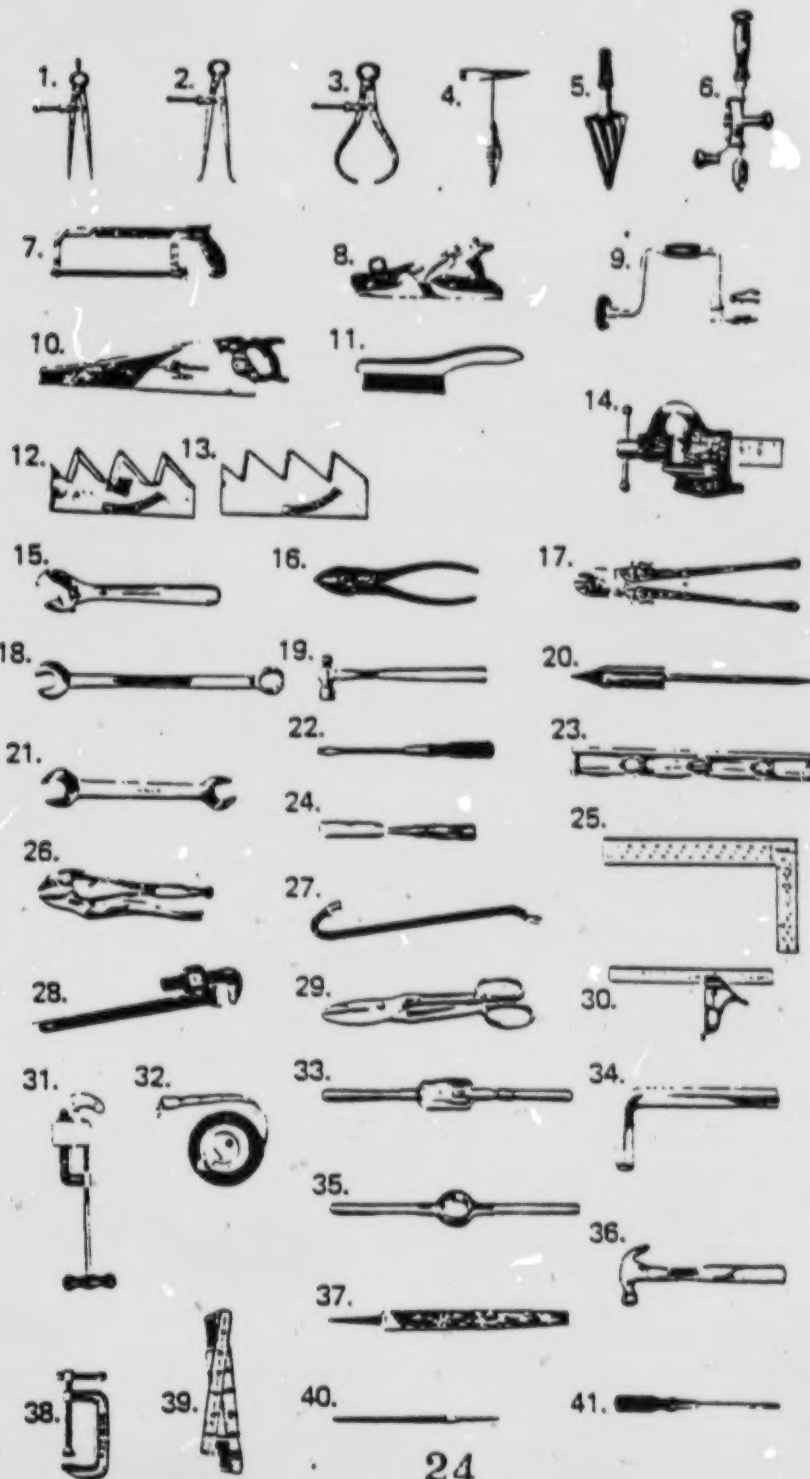
- | | |
|--|------------|
| _____ a. Fires that occur with flammable liquids, such as gasoline, oil, grease, paints, and thinners | 1. Class A |
| _____ b. Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish | 2. Class B |
| _____ c. Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring | 3. Class C |
| _____ d. Fires that occur with combustible metals, such as magnesium | 4. Class D |

11. Match the type of fire extinguisher best suited to extinguish each class of fire. Answers may be used more than once.

- | | |
|---|--------------------------------------|
| _____ a. Fires that occur with flammable liquids such as gasoline, oil, or grease | 1. Pressurized Water |
| _____ b. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring | 2. Carbon Dioxide (CO ₂) |
| _____ c. Fires that occur in ordinary combustible materials such as magnesium | 3. Dry Chemical |
| | 4. Soda Acid |
| | 5. Foam |

12. Identify 30 of the 41 tools below. Use the answer sheet provided making sure the tool identified matches the number of the tool and answer sheet.

(NOTE: Instructor may want to add additional tools.)



ANSWER SHEET FOR TOOLS

- | | |
|-----|-----|
| 1. | 22. |
| 2. | 23. |
| 3. | 24. |
| 4. | 25. |
| 5. | 26. |
| 6. | 27. |
| 7. | 28. |
| 8. | 29. |
| 9. | 30. |
| 10. | 31. |
| 11. | 32. |
| 12. | 33. |
| 13. | 34. |
| 14. | 35. |
| 15. | 36. |
| 16. | 37. |
| 17. | 38. |
| 18. | 39. |
| 19. | 40. |
| 20. | 41. |
| 21. | |

13. Indicate a willingness to work safely by subscribing to the student safety pledge form.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

ORIENTATION AND GENERAL SAFETY
UNIT I

ANSWERS TO TEST

1. All the unspecialized mechanical activities performed on the farm and in the home including instruction in the following areas:
agricultural shopwork, agricultural power and machinery, agricultural buildings and conveniences, rural electrification, and soil and water management
2. Any two of the following:
 - a. Most of the work involves some type of mechanical activity
 - b. Approximately 85% of machinery in operation is out of adjustment
 - c. Must be able to service and maintain all equipment used
3. b, c, d
4. Any ten of the following:
 - a. Store equipment being repaired or constructed in an orderly fashion at the end of the work period
 - b. Clean and store tools, helmets, and goggles in their proper place at the end of the work period
 - c. Report broken tools to the teacher
 - d. Place oily rags in covered cans
 - e. Turn off all arc welders when job is done
 - f. Shut off oxyacetylene welding outfits at cylinders, drain hoses, close oxygen and acetylene blow pipe valves, clean welding tables, and restore rods to the holders at the close of the work period
 - g. Be responsible for the area or station assigned to you
 - h. Brush all benches, tables, and the floor at the end of work period
 - i. Keep tools in their proper places
 - j. Do not scuffle or join in horseplay in the shop
 - k. Do not run in the shop
 - l. Do not work with tools with which you have not received instruction
 - m. Make sure that all electrical equipment is turned off at the end of the day

- n. Use tools for their specific purpose
 - o. Supply all visitors with face shields upon entering the shop
 - p. Store personal property including project property in designated locations
 - q. Do not waste time
 - r. Check all clothes before returning them to lockers after class time
5. a. 2
- b. 4
- c. 6
- d. 1
- e. 3
- f. 5
- g. 7
6. a. Reduces glare by diffusing sufficient light for better vision throughout the shop
- b. Reduces eyestrain, tension, and fatigue by "setting off" material from machines and work areas
- c. Promotes safety by pointing out critical parts and areas
- d. Promotes better housekeeping by providing a more pleasing environment
7. Discussion should include:
- a. EYE PROTECTIVE DEVICES---ARE REQUIRED TO BE WORN IN CERTAIN COURSES OF INSTRUCTION
 - b. Protects student and teacher participating in or observing instruction
 - c. Cautions against harmful conditions
 - 1) Hot molten metals or other molten materials
 - 2) Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials
 - 3) Heat treatment, tempering, or kiln firing of any metal of other materials
 - 4) Gas or electric arc welding or other forms of welding processes
 - 5) Repair or servicing of any vehicle where there is danger of injury to the eyes
 - 6) Caustic or explosive materials

19. Ball-penn hammer
20. Soldering copper
21. Open-end wrench
22. Standard screwdriver
23. Carpenter's level
24. Wood chisel
25. Steel-framing square
26. Vise-grip pliers
27. Wrecking bar
28. Pipe wrench
29. Tinner's snips
30. Combination square
31. Pipe cutter
32. Steel tape
33. Tap wrench
34. Allen wrench
35. Diestock
36. Curved claw hammer
37. Flat file
38. C-clamp
39. Folding rule
40. Round file
41. Phillips screwdriver

(others as added by instructor.)

13. Evaluated to the satisfaction of the instructor.

FARM SAFETY
UNIT X

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to list safety rules to observe when operating a tractor and other farm machinery. He should be able to define terms and name the major cause of accidents. He should also be able to state rules of safety around home and farm buildings and around livestock. This knowledge will be evidenced by scoring ninety percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with farm safety to the correct definition.
2. Name the major cause of accidents.
3. List the three steps of accident prevention.
4. State the number of accidents in all industries as compared to agriculture.
5. Name three general home and building safety practices.
6. State four safety rules to observe when working around livestock.
7. Name three ways tractors upset.
8. State three precautions that can reduce tractor upsets.
9. Write five precautions that should be observed when operating a tractor.
10. List five safety rules to follow to reduce falls from tractors.
11. List three safety measures to observe when refueling a tractor.
12. List five safety precautions to be observed in the safe operation of farm machinery.
13. List characteristics of a safe tractor operator.
14. Draw a slow moving vehicle emblem.
15. Name four provisions under which a 14 to 15 year old can operate a farm tractor.

FARM SAFETY
UNIT X

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheet.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Give test

(NOTE: Instructors may want to secure safety films from the National Safety Council to show to class. There are many good films available. The instructor may also want to take the class to a machinery dealer to see some of the equipment. Also, a driving course may be set up for practice.)

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
 - 1. TM 1 - Accidents - Farm Population
 - 2. TM 2 - Safe Tractor Operation
 - 3. TM 3 - Safe Operation
 - 4. TM 4 - Slow Moving Vehicle Emblem (SMV)
- D. Test
- E. Answers to test

II. References:

- A. Shepp, Neil O. Vocational Agriculture Training Program: Safe Tractor Operation and Safe Farm Machinery Operation. East Lansing, Michigan: Rural Manpower Center, Michigan State University, 1970

- B. Tractor Operation and Daily Care. Athens, Georgia: American Association of Vocational Instructional Materials, 1967.
- C. Farm Tractors. Chicago, Illinois: American Oil Co., 1964.
- D. Instructional Materials for Vocational Agriculture I. College Station, Texas: Teaching Materials Center, Agricultural Education Department, Texas A & M University.
- E. Machinery Care and Safety. Chicago, Illinois: 4-H Tractor Program, National 4-H Service Committee, 1963.

FARM SAFETY
UNIT X

INFORMATION SHEET

I. Terms and definitions

- A. Accident - That occurrence in a sequence of events which usually produces intended injury or property damage
- B. Safety - The condition of being safe from undergoing or causing harm, injury, or loss
- C. Hazard - A source of danger

II. Major cause of accidents--Carelessness

III. Steps of accident prevention

A. See the hazard

(NOTE: One should think about what is going to happen or what might happen as far ahead of encountering the situation as possible.)

B. Know the defense

(NOTE: There are specific ways of handling specific situations. Learn them and learn them well so you can apply them.)

C. Act in time

(NOTE: Once you have seen the hazard and you select the defense against it, act. Never take a "wait and see" attitude.)

IV. Number of accidents in all industries as compared to agriculture (Transparency 1)

A. 2,200,000 accidents a year in all industries

B. 290,000 accidents a year in agriculture

(NOTE: Agriculture leads all industries with the largest number of deaths and injuries due to accidents.)

V. General home and building safety practices

A. Remove all fire hazards

B. Provide fire extinguishers for all parts of the farm

C. Eliminate rats, mice, and insects if possible

D. Store tools and equipment in appropriate places

E. Check farm wiring for electrical hazards

- F. Do not operate internal combustion engines in a closed building or room

VI. Safety in working with and handling livestock

- A. Approach animals carefully
- B. Treat bulls, stallions, rams and boars as potential hazards
- C. Remove nails and broken boards from fences and corrals
- D. Try to prevent livestock losses by careful supervision
- E. Load and haul animals carefully to avoid injury
- F. Vaccinate livestock to avoid disease

VII. Three ways tractors may upset

- A. Sideways
- B. Backward
- C. Frontward

VIII. Precautions that can reduce tractor upset

- A. Set wheels wide as practical for the job
- B. Add front or rear weights to properly balance tractor
- C. Hitch only to drawbar, set no higher than 18" or to specific hitch points
- D. Lower loader bucket when traveling and before dismounting
- E. Run and maintain tractor according to operator's manual

IX. Precautions for operating tractors (Transparency 2)

- A. Slow down when making turns
- B. Adjust brakes so that the same pedal travel will give equal braking on both wheels
- C. Do not rest your foot on the clutch after it is engaged
- D. Leave tractor in gear when going downhill
- E. Do not attempt to change gears in motion if your tractor has a hand shift transmission
- F. Provide for night operation of equipment
 - 1. On tractor
 - a. Two head lamps
 - b. One tail lamp
 - c. Flashing warning lamp is highly practical

- 2. On towed or mounted equipment
- 3. On projecting parts of equipment
- G. Do not drive close to the edge of ditches or banks
- H. Do not ride on the tractor drawbar
- I. Do not allow passengers on the tractor
- J. Attach all towed equipment to the drawbar
- K. Use a close hitch for all jobs if possible
- L. Let the drawbar swing freely on heavy loads
- M. When stuck in mud, back out if possible or pull with another tractor
- N. When operating on the highway
 - 1. Provide safety warning devices, such as a slow moving vehicle (SMV) emblem (Transparency 3)
 - 2. Use the highway right-of-way
- O. Others that may be added by the instructor
- X. Safety rules to reduce falls from tractors
 - A. Do not allow additional riders
 - B. Use hand and foot aids provided when mounting or dismounting
 - C. Step on or off a tractor only when it is stopped
 - D. Keep operator's platform clear
 - E. Avoid riding on fender and drawbar
 - F. Slow down when crossing rough ground
 - G. Keep alert for low hanging overhead obstructions
- XI. Safety measures to observe when refueling
 - A. Turn the tractor off
 - B. Check against fire hazards
 - C. Let tractor engine cool
 - D. Do not fill tank completely full
 - E. Replace fuel cap tightly
 - F. Do not smoke when refueling
 - G. Check daily for leaks
- XII. Safety precautions in safe operation of farm machinery
 - A. Turn off machine before working on it or making adjustments
 - B. Always keep all shields in place

- C. Dress appropriately and do not work when fatigued
- D. Set the brakes when you leave the tractor
- E. Keep all equipment in proper adjustment
- F. Do not use a stick to unclog a machine when it is running
- G. Be careful of others
- H. Never attempt to operate a machine unless you know how
- I. Anchor belt-driven equipment securely
- J. Line the tractor pulley, belt, and machine pulley
- K. Keep PTO, gear and belt shields in place

XIII. Characteristics of a safe tractor operator (Transparency 3)

- A. Must have knowledge

(NOTE: This includes how to recognize hazards and how to protect one's self as well as experience and training.)

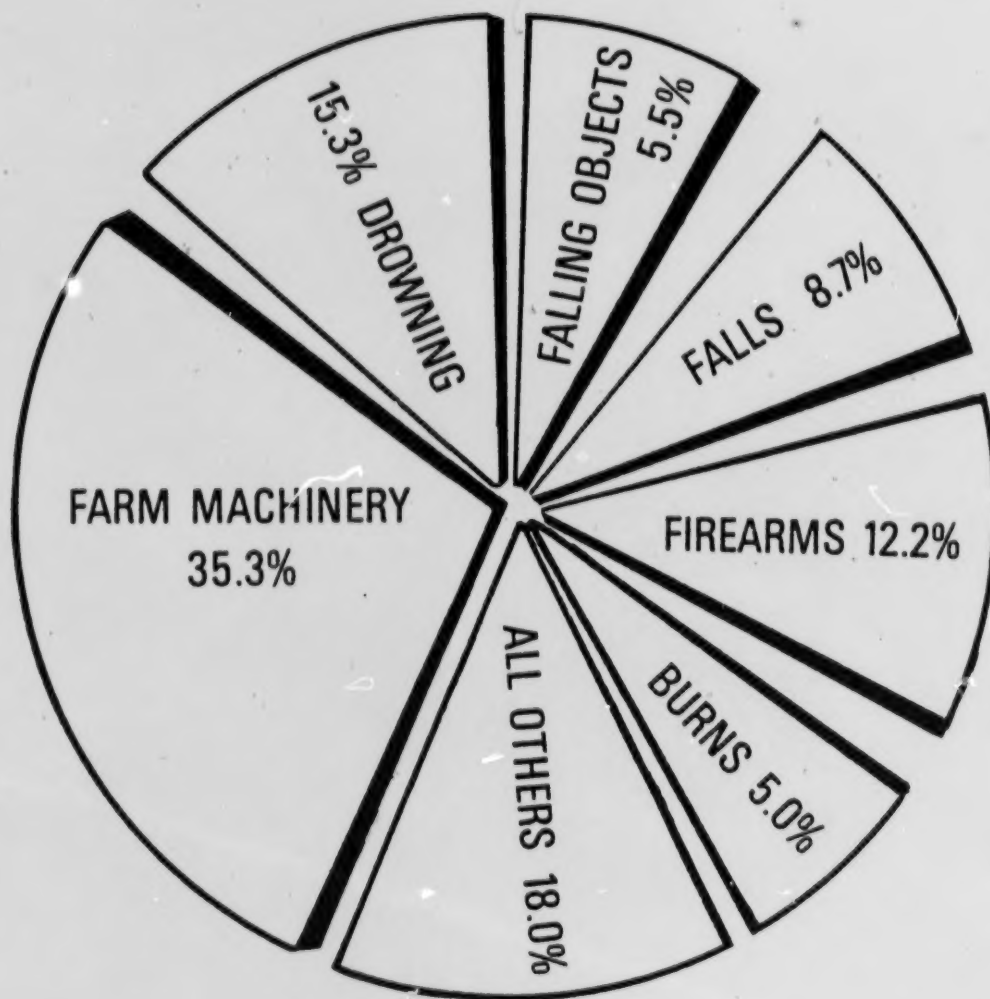
- B. Must be alert
- C. Must have foresight
- D. Must be able to make judgement
- E. Must have skill

XIV. Slow-moving-vehicle sign (Transparency 4)

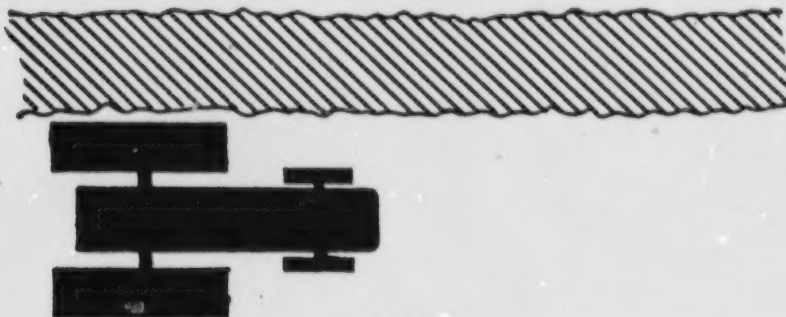
XV. Provisions under which 14 or 15 year olds can operate a farm tractor

- A. Operating for his parents
- B. Has completed 15 hours of safety instruction and received a certificate to this effect
- C. Operation of the tractor is part of his supervised work experience in Vo-Ag
- D. Operation of the tractor is part of his 4-H project

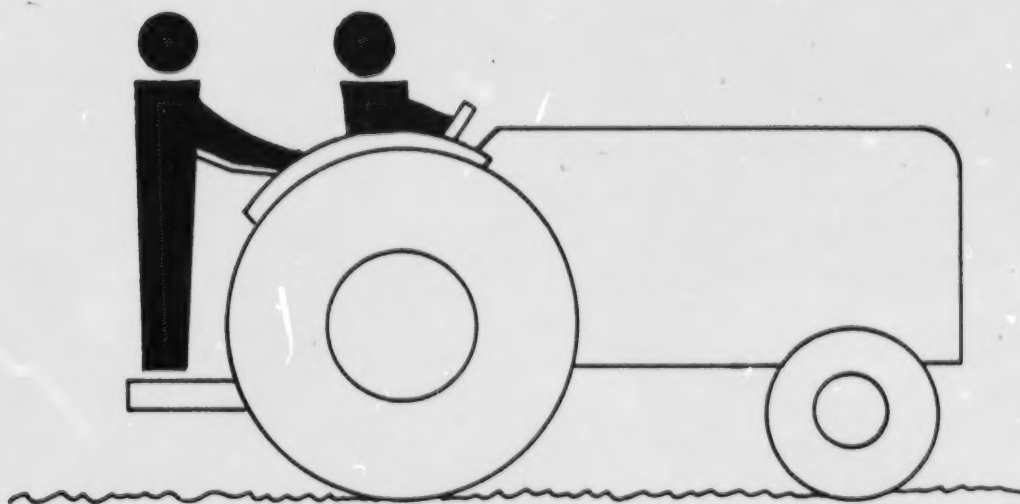
Accidents – Farm Population



Safe Tractor Operation

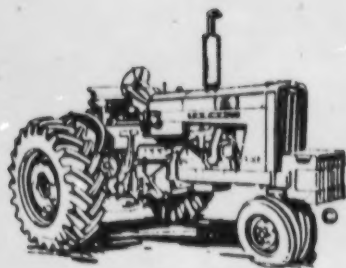


Do Not Drive Close to the Edge of Ditches or Banks

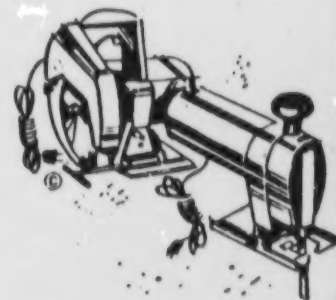


Do Not Ride the Tractor Drawbar and
Do Not Allow Passengers on the Tractor

Safe Operation

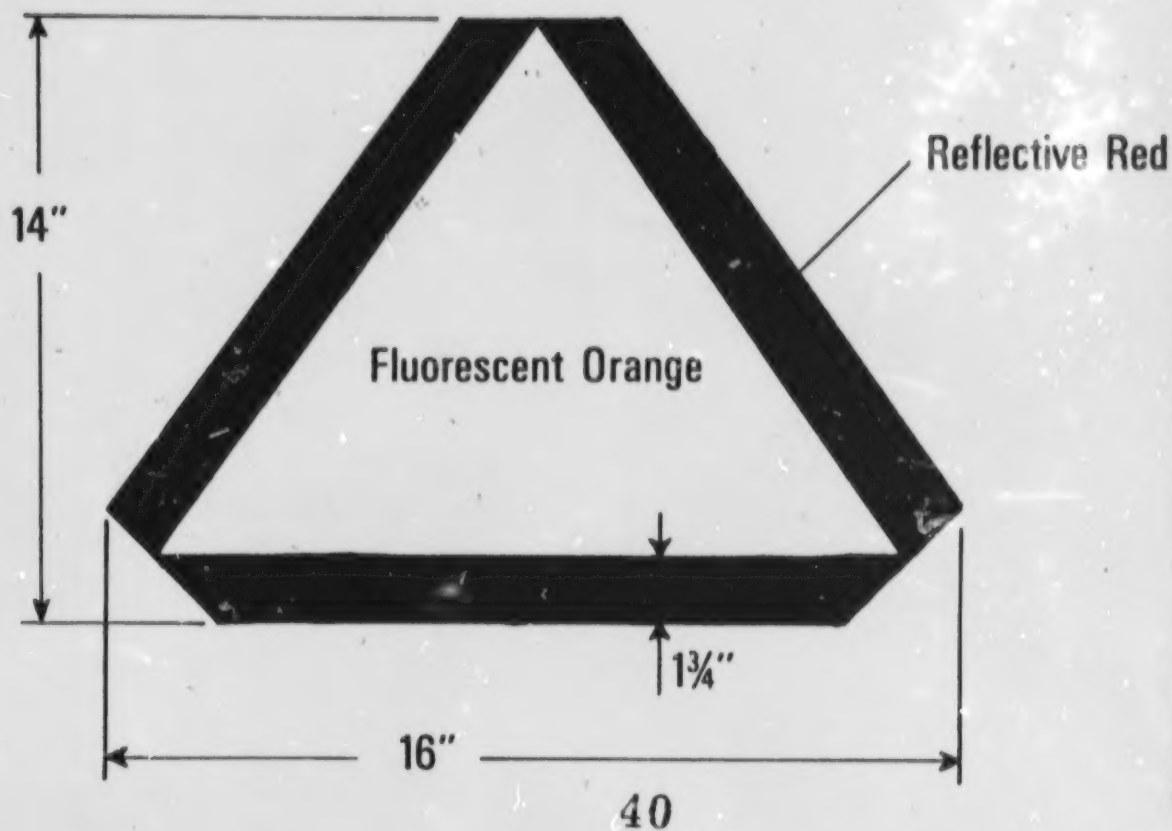


- Knowledge
- Alertness
- Foresight
- Judgement
- Skill



Slow Moving Vehicle Emblem

SMV



FARM SAFETY
UNIT X

TEST

1. Match the terms on the right to the correct definition.

- | | |
|--|-------------|
| _____ a. A source of danger | 1. Accident |
| _____ b. That occurrence in a sequence of events which usually produces unintended injury or property damage | 2. Safety |
| _____ c. The condition of being safe from undergoing or causing harm, injury, or loss | 3. Hazard |

2. Name the major cause of accidents.

3. List three steps of accident prevention.

- a.
- b.
- c.

4. State the number of accidents in all industries as compared to agriculture.

- a. All industries _____
- b. Agriculture _____

5. Name three general home and building safety practices.

- a.
- b.
- c.

6. State four safety rules to observe when working around livestock.

- a.
- b.
- c.
- d.

7. Name three ways tractors upset.
 - a.
 - b.
 - c.
8. State three precautions that can reduce tractor upset.
 - a.
 - b.
 - c.
9. Write five precautions that should be observed when operating a tractor.
 - a.
 - b.
 - c.
 - d.
 - e.
10. List five safety rules to follow to reduce falls from tractors.
 - a.
 - b.
 - c.
 - d.
 - e.
11. List three safety precautions to observe when refueling a tractor.
 - a.
 - b.
 - c.
12. List five safety precautions to be observed in the safe operation of farm machinery.
 - a.
 - b.
 - c.
 - d.
 - e.

13. List characteristics of a safe tractor operator.

- a.
- b.
- c.
- d.
- e.

14. Draw a slow moving vehicle emblem.

15. List four provisions under which a 14 or 15 year old can operate a farm tractor.

- a.
- b.
- c.
- d.

FARM SAFETY
UNIT X

ANSWERS TO TEST

1. a. 3
b. 1
c. 2
2. Carelessness
3. a. See the hazard
b. Know the defense
c. Act in time
4. a. 2,000,000
b. 290,000
5. Any three of the following:
 - a. Remove all fire hazards
 - b. Provide fire extinguisher for all parts of the farm
 - c. Eliminate rats, mice, and insects if possible
 - d. Store tools, guns, and equipment in appropriate places
 - e. Check farm wiring for electrical hazards
 - f. Do not operate internal combustion engines in a closed building or room
6. Any four of the following:
 - a. Approach animals carefully
 - b. Treat bulls, stallions, and rams as potential hazards
 - c. Remove nails and broken boards from fences and corrals
 - d. Try to prevent livestock losses by careful supervision
 - e. Load and haul animals carefully to avoid injury
 - f. Vaccinate livestock to avoid disease

7.
 - a. Sideways
 - b. Backward
 - c. Frontward

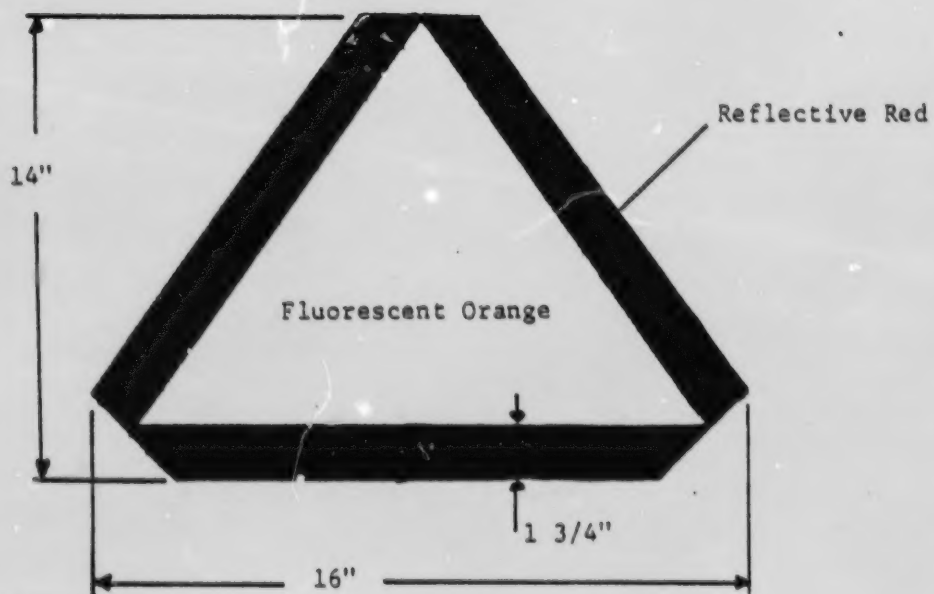
8. Any three of the following:
 - a. Set wheels wide as practical for the job
 - b. Add front or rear weights to properly balance tractor
 - c. Hitch only to drawbar set no higher 18" or to specific hitch points
 - d. Lower loader bucket when traveling and before dismounting
 - e. Run and maintain tractor according to operator's manual

9. Any five of the following:
 - a. Slow down when making turns
 - b. Adjust brakes so that the same pedal travel will give equal braking on both wheels
 - c. Do not rest your foot on the clutch after it is engaged
 - d. Leave the tractor in gear when going downhill
 - e. Do not attempt to change gears in motion if your tractor has a hand shift transmission
 - f. Provide for night operation of equipment
 - g. Do not drive close to the edge of ditches or banks
 - h. Do not ride on tractor drawbar
 - i. Do not allow passengers on the tractor
 - j. Attach all towed equipment to the drawbar
 - k. Use a close hitch for all jobs if possible
 - l. Let the drawbar swing freely on heavy loads
 - m. When stuck in mud, back out if possible or pull with another tractor
 - n. When operating on the highway
 - 1) Provide safety warning devices
 - 2) Use the highway right-of-way
 - o. Others may be added by instructor

10. Any five of the following:
 - a. Do not allow additional riders
 - b. Use hand and foot aids provided when mounting or dismounting
 - c. Step on or off a tractor only when it is stopped

- d. Keep operator's platform clean
 - e. Avoid riding on fenders and drawbar
 - f. Slow down when crossing rough ground
 - g. Keep alert for low hanging overhead obstructions
11. Any three of the following:
- a. Turn the tractor off
 - b. Check against fire hazards
 - c. Let tractor engine cool
 - d. Do not fill tank completely full
 - e. Replace fuel cap tightly
 - f. Do not smoke when refueling
 - g. Check daily for leaks
12. Any five of the following:
- a. Turn off machine before working on it or making adjustments
 - b. Always keep all shields in place
 - c. Dress appropriately and do not work when fatigued
 - d. Set the brakes when you leave the tractor
 - e. Keep all equipment in proper adjustment
 - f. Do not use a stick to unclog a machine when it is running
 - g. Be careful of others
 - h. Never attempt to operate a machine unless you know how
 - i. Anchor belt-driven equipment securely
 - j. Line the tractor pulley, belt, and machine pulley
 - k. Keep PTO, gear and belt shields in place
13. a. Must have knowledge
- b. Must be alert
 - c. Must have foresight
 - d. Must be able to make judgment
 - e. Must have skill

14.



15. a. Operating for his parents.
b. Has completed 15 hours of safety instruction and received a certificate to this effect
c. Operation of the tractor is part of his supervised work experience in Vo-Ag
d. Operation of the tractor is part of his 4-H project

FIGURING BILLS OF MATERIALS

TERMINAL OBJECTIVE

After completion of Unit VI, the student should be able to figure bills of materials. He should be able to distinguish between board feet and running feet and demonstrate the procedures for calculating them. This knowledge will be evidenced by scoring eighty-five percent on a post test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define four terms associated with bills of materials
2. Name the unit of measure for selling lumber.
3. Indicate in writing the basic measurements in width and length that most lumber is sold by.
4. Name two ways in which metal is usually sold.
5. Write the formula for figuring board feet.
6. List the specifications needed for writing a bill of material.
7. Recognize symbols used in selecting lumber.
8. Write the formula used in calculating the cost of lumber.
9. Write the formula used in calculating the cost of steel.
10. Calculate problems determining board feet.
11. Calculate problems determining the cost of steel.

FIGURING BILLS OF MATERIALS
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and assignment sheets.
- C. Discuss terminal and specific objectives.
- D. Discuss information and assignment sheets
- E. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheets and complete assignment sheet.
- C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Assignment sheets
 - #1 - Calculating Board Feet
 - #2 - Calculating Cost of Steel
- D. Answers to assignment sheet
- E. Test
- F. Answers to test

II. References:

- A. Shopwork on the Farm, Mack M. Jones, McGraw-Hill Book Company, New York, New York, 1955.
- B. Farm Mechanics Text and Handbook, Lloyd J. Phipps, H.F. McColly, L.L. Scranton, and G.C. Cook, Interstate Publishers and Printers, Danville, Illinois.

FIGURING BILLS OF MATERIALS
UNIT VI

INFORMATION SHEET

I. Terms and definitions

- A. Bill of material - An itemized list of the number of pieces needed and the dimensions of each for the construction of a project.
- B. Board foot - A piece of lumber one inch thick, 12 inches wide and 12 inches long
- C. Running foot - The foot length of material regardless of the thickness and the width
- D. Surfaced lumber - The lumber that has been dressed by running through a planer
- E. Rough stock - The lumber that has been sawed but not planed; thicker and wider
- F. Square foot - Equal to a twelve by twelve surface
- G. Cubic foot - A twelve by twelve by twelve surface
- H. A square - Equal to a 100-square-foot

II. Selling lumber

- A. Measured in board foot
- B. Priced on a basis of 1,000 board feet

III. Types of lumber dimensions

A. Width

- 1. 4 inches
- 2. 6 inches
- 3. 8 inches
- 4. 10 inches
- 5. 12 inches

B. Length

- 1. 6 feet
- 2. 8 feet
- 3. 10 feet
- 4. 12 feet
- 5. 14 feet

IV. Metal sold by

- A. Square foot
- B. Weight converted to feet

V. Formula for figuring board feet

- A. No. of pieces by thickness in in. by width in in. by length in ft.
divided by 12

B. Example

- 1. One board 1" thick by 4" wide by 12' long
- 2. $\frac{1 \times 1" \times 4" \times 12'}{12} = 4 \text{ board feet}$

VI. Specifications required for writing a bill of material

- A. Easy understanding
- B. Number of pieces
- C. Kind of material (lumber, steel, etc.)
- D. Dimensions
- E. Finish
- F. Amount (board feet, square feet, squares, etc.)
- g. Calculation of cost per piece
- H. Examples of procedures

1.	<u>Pieces</u>	<u>Kind of Material</u>	<u>Dimension</u>	<u>Finish</u>	<u>Amount</u>	<u>Cost per Piece</u>
	3	White Pine	1" x 12" x 10'	S2S	30 Bd. Ft	\$1.10
2.	<u>Pieces</u>	<u>Dimension</u>	<u>Kind of Material</u>	<u>Use</u>		
	2	2" x 4" x 24'	Pine	Rafters		

VII. Lumber symbols

- A. S1S - Surfaced on one side
- B. S2S - Surfaced on two sides
- C. S1E - Surfaced on one edge
- D. S2E - Surfaced on two edges
- E. S4S - Surfaced on four sides

VIII. Calculating the cost of lumber

- A. Figure board feet of one piece
- B. Multiply this number by the cost per thousand
- C. Point off three places
- D. Example - One board 2" x 8" x 12' at \$60.00 per M (1,000 board feet)

$$E. \frac{1 \times 2'' \times 8'' \times 12'}{12} = 16 \text{ board feet}$$

$$16 \text{ bd. ft. by } \$60.00 = .96 \text{ cents}$$

IX. Calculating the cost of steel

- A. Pipe and Square tubing

$$\text{Number of Pieces} \times \frac{\text{Length in ft.}}{100} \times \text{Price/CFT} = \text{Value or Cost}$$

Example:

$$12 \times \frac{30' \text{ of } 1'' \text{ pipe}}{100} \times \$55.00/\text{CFT} = 3.60 \text{ units} \times \$55.00 = \$198.00$$

- B. Structural Steel - Plates, flats, strips, rounds, bars, angles, channels, etc.

$$\frac{\text{Amount in number of units}}{100} \times \frac{\text{Weight in pounds/units}}{100} \times \text{Price/CWT} = \text{Value or cost}$$

Example:

$$\frac{145' \text{ of } 2 \times 2 \times 3/16'' \text{ angle}}{100} \times \frac{2.44\#/ft.}{100} \times \$23/\text{CWT} = \$81.38$$

FIGURING BILLS OF MATERIALS
UNIT VI

ASSIGNMENT SHEET #1 - CALCULATING BOARD FEET

Calculate the total board feet in each

Formula $\frac{\text{Pieces} \times \text{Thickness} \times \text{Width} \times \text{Length}}{12}$

1. 1--1" by 10" by 10' =
2. 1--1" by 4" by 14' =
3. 1--2" by 6" by 8' =
4. 1--2" by 8" by 10' =
5. 2--2" by 4" by 8' =
6. 5--1" by 8" by 8' =
7. 10--4" by 6" by 10' =
8. 1--2" by 4" by 18' =
9. 7--10" by 12" by 20' =
10. 3--1" by 2" by 6' =

FIGURING BILLS OF MATERIALS
UNIT VI

ASSIGNMENT SHEET #2 - CALCULATE THE COST OF STEEL

Calculate the cost of steel in each of the problems listed below.

Formula for pipe and square tubing costs:

$$\frac{\text{Length in ft.}}{100} \times \text{Price/CFT} = \text{Cost or value of material}$$

1. 8pc.--20' lengths of 1" square tubing priced at \$48/CFT
2. 2pc.--20' lengths at 3" 1D pipe priced at \$255/CFT

Formula for structural steel costs:

$$\frac{\text{Amount in units} \times \text{wgt./unit}}{100} \times \text{Price/CWT} = \text{Cost or value}$$

3. 375' of 2 1/2" x 2 1/2" x 1/4" angle priced at \$31/CWT;
Angle weighs 4.1#/ft.
4. 40 sq. ft. of 1/8" flat priced at \$30.50/CWT;
Flat weighs 5.1#/sq ft.
5. 105 ft. of 3/8" round priced at \$50/CWT;
3/8" round weighs 0.376#/ft.

FIGURING BILLS OF MATERIALS
UNIT VI

ANSWERS TO ASSIGNMENT SHEET #1

1. 8.3 board feet
2. 4.6 " "
3. 8 " "
4. 13.3 " "
5. 10.6 " "
6. 26.5 " "
7. 200 " "
8. 12 " "
9. 1,400 " "
10. 3 " "

ANSWERS TO ASSIGNMENT SHEET #2

1. \$76.80
2. \$102.00
3. \$476.63
4. \$62.22
5. \$19.78

FIGURING BILLS OF MATERIALS
UNIT VI

TEST

1. Define the following terms.

a. Board foot -

b. Running foot -

c. Bill of material -

d. Surfaced lumber -

2. What is the unit of measure for selling lumber?

3. Write the common dimensions of lumber in width and length.

Width

Length

a.

a.

b.

b.

c.

c.

d.

d.

e.

e.

4. Name two ways in which metal is usually sold.

a.

b.

5. Write the formula for figuring board feet.

6. What are the specifications required for writing a bill of material?

a.

b.

c.

d.

e.

f.

g.

7. Match the terms on the left with the statements on the right.

a. _____ S1S

b. _____ S2S

c. _____ S1E

d. _____ S2E

e. _____ S4S

1. Lumber that has been surfaced on two sides

2. Lumber that has been surfaced on two edges

3. Lumber that has been surfaced on one side

4. Lumber that has been surfaced on one edge

5. Lumber that has been surfaced on four sides

8. Write the formula used in calculating the cost of lumber.

9. Write the formulas used in calculating the cost of steel.

a.

b.

10. Determine the board feet in the following problems.

a. 3 - 2" x 4" x 12' =

b. 1 - 1" x 4" x 10' =

c. 15 - 2" x 10" x 20' =

d. 6 - 4" x 4" x 10' =

FIGURING BILLS OF MATERIALS
UNIT VI

ANSWERS TO TEST

1.
 - a. Board foot - A piece of lumber one inch thick, 12 inches wide, and 12 inches long
 - b. Running foot - The foot length of lumber regardless of the thickness and the width
 - c. Bill of material - An itemized list of the number of places needed and the dimensions of each
 - d. Surfaced lumber - The lumber that has been dressed by running through a planer
2. Board foot, priced on the basis of 1,000 board feet
3.

Width	Length
a. 4"	a. 6'
b. 6"	b. 8'
c. 8"	c. 10'
d. 10"	d. 12'
e. 12"	e. 14'
4.
 - a. Square foot
 - b. Weight converted to feet
5.
$$\frac{\text{No. of pieces} \times \text{Thickness} \times \text{Width} \times \text{Length}}{12} = \text{Board Feet}$$
6.
 - a. Easy understanding
 - b. Number of pieces
 - c. Kind of material
 - d. Dimension
 - e. Finish
 - f. Amount
 - g. Calculation of cost per piece
7.
 - a. 3
 - b. 1
 - c. 4
 - d. 2
 - e. 5

8. Board feet x cost per 1,000 = cost of lumber

9. a. Number of pieces x $\frac{\text{Length in feet}}{100}$ x Price/CFT = Value or cost

b. $\frac{\text{Amount in number of units}}{100}$ x $\frac{\text{Weight in pounds/unit}}{100}$ x Price/CWT = Value or cost

10. a. 24 board feet
b. 3.3 board feet
c. 500 board feet
d. 80 board feet

IGNITION SYSTEM UNIT IX

TERMINAL OBJECTIVE

After completion of Unit IX, the student should be able to select from a list the components of the primary and secondary ignition circuits. He should be able to identify the components of a battery powered ignition system and components of a distributor. The student should be able to check the condition of a distributor, replace breaker points, and adjust breaker points. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the ignition system to the proper definition.
2. Explain in writing the purpose of the ignition system.
3. Select from a list the components of the primary and secondary ignition circuits.
4. Identify the components of a battery powered ignition system.
5. Identify the components of a distributor.
6. List reasons why points may be badly burned.
7. Name two methods of timing an engine.
8. List two reasons why engine timing is important.
9. Name three indications of timing being too late.
10. Name two indications of timing being too early.
11. Demonstrate the ability to:
 - a. Check the condition of the distributor
 - b. Replace breaker points
 - c. Adjust breaker points
 - d. Time an engine by the breaker-point method
 - e. Time an engine by the timing-light method

IGNITION SYSTEM
UNIT IX

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in job sheets.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
 - 1. TM 1 - Primary Circuit
 - 2. TM 2 - Secondary Circuit
 - 3. TM 3 - Battery Powered Ignition System
 - 4. TM 4 - Distributor Components
- D. Job sheets
 - 1. Job Sheet #1 - Check the Condition of the Distributor
 - 2. Job Sheet #2 - Replace Breaker Points
 - 3. Job Sheet #3 - Adjust Breaker Points
 - 4. Job Sheet #4 - Timing an Engine by the Breaker-Point Method
 - 5. Job Sheet #5 - Timing an Engine by the Timing-Light Method

E. Test

F. Answers to test

II. References:

- A. Tractor Maintenance. American Association for Instructional Materials. Athens, Georgia: Foote and Davie (Division of McCall Printing Company), 1970.
- B. Auto Mechanics Instructional Units. Curriculum and Instructional Materials Center, Stillwater, Oklahoma, 1971.
- C. Fundamentals of Machine Operation-Preventive Maintenance. John Deere Service Publications (Deere and Company, Moline, Illinois) 1973.

IGNITION SYSTEM
UNIT IX

INFORMATION SHEET

I. Terms and definitions

- A. Battery - A source of electrical power
- B. Ignition switch - Opens and closes the primary circuit from battery to the contact points
- C. Resistance unit - Reduces voltage in the primary circuit to protect the contact points
- D. Ignition coil - Transforms low voltage into high voltage necessary to jump the spark plug gap
- E. Contact points - Make and break the primary circuit to allow the coil to produce high voltage at the spark plugs
- F. Condensor - Stores extra current as the contact points open to prevent arcing and burning
- G. Distributor - Contains the contact points and condensor; distributes the high voltage current from the coil to the proper cylinder
- H. Breaker cam - Opens and closes the contact points
- I. Spark-advance mechanisms - Regulates the timing of the high voltage circuit for the best ignition during all speed and load conditions
- J. Rotor - Takes the high voltage current from the coil and directs it to the correct cylinder
- K. Distributor cap - Holds the coil and spark plug wires in a sequence and provides a cover for the distributor
- L. Spark plug - Provides a spark gap inside the engine cylinder to ignite the fuel air mixture
- M. Primary ignition wire - Carries low voltage from the battery to the primary side of the ignition coil (light wire)
- N. Secondary ignition wire - Carries high voltage from the secondary side of the coil to the spark plug (heavily insulated wire)

II. Purpose of the ignition system - To produce high voltage current to ignite the fuel air mixture in the engine cylinders

III. Ignition system circuits

- A. Primary - Low voltage circuit (Transparency 1)

1. Battery
2. Ignition switch
3. Resistance unit
4. Primary winding of the coil
5. Contact points
6. Condensor
7. Low voltage wire that connects the units

B. Secondary - High voltage circuit (Transparency 2)

1. Secondary winding of the coil
2. Distributor cap
3. Rotor
4. Spark plug
5. High voltage wire that connects the units

IV. Parts of a battery-powered ignition system (Transparency 3)

- A. Ignition switch
- B. Battery
- C. Ignition coil
- D. Distributor
- E. Spark plugs
- F. Spark-plug wires

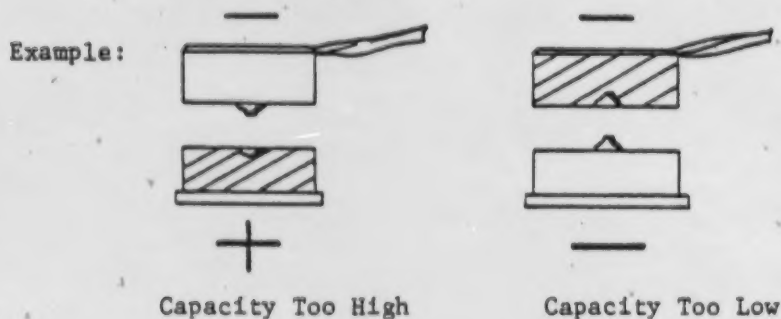
V. Distributor components (Transparency 4)

- A. Distributor cap
- B. Rotor
- C. Centrifugal advance mechanism
- D. Condensor
- E. Vacuum advance
- F. Breaker plate
- G. Distributor cam
- H. Contact points
- I. Distributor housing
- J. Primary lead wire
- K. Distributor drive gear
- L. Dust Caps

VI. Reasons for badly burned points

- A. Oil or foreign material on the contact surface
- B. A contact-point gap adjustment that is either too wide, too close, or points that are out of alignment
- C. A defective condenser

(NOTE: If the condenser is not working properly or is not of the proper capacity for your ignition system, there will be a cone-shaped deposit of metal on one point and a cone-shaped pit on the other.)



Check tightness of screw that hold the condenser. This screw is also ground connection and must be tight.

VII. Methods of timing an engine

- A. The breaker-point method
- B. The timing-light method

VIII. Importance of proper timing

- A. Increase horsepower
- B. Decrease fuel consumption

(NOTE: Ignition is set so the distributor will supply a spark to each cylinder at a time when the fuel will burn with greatest efficiency. That will supply the most economical power.)

IX. Indications of timing too late

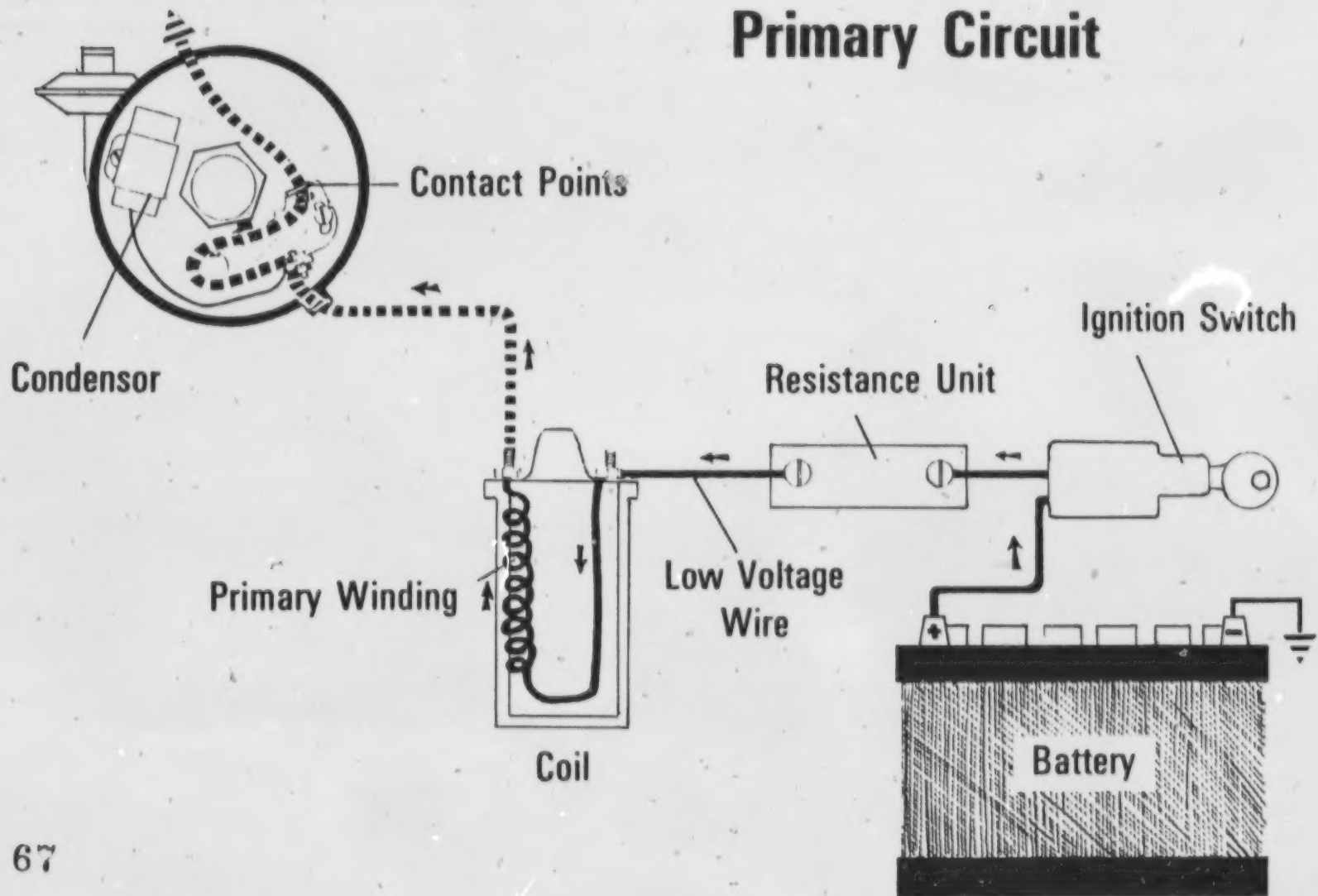
- A. Retarded spark causes late firing
- B. Exhaust gases escape while they are still quite hot
- C. Wastes power
- D. Increase in exhaust gas temperature
- E. Warped valves

X. Indication of timing too early

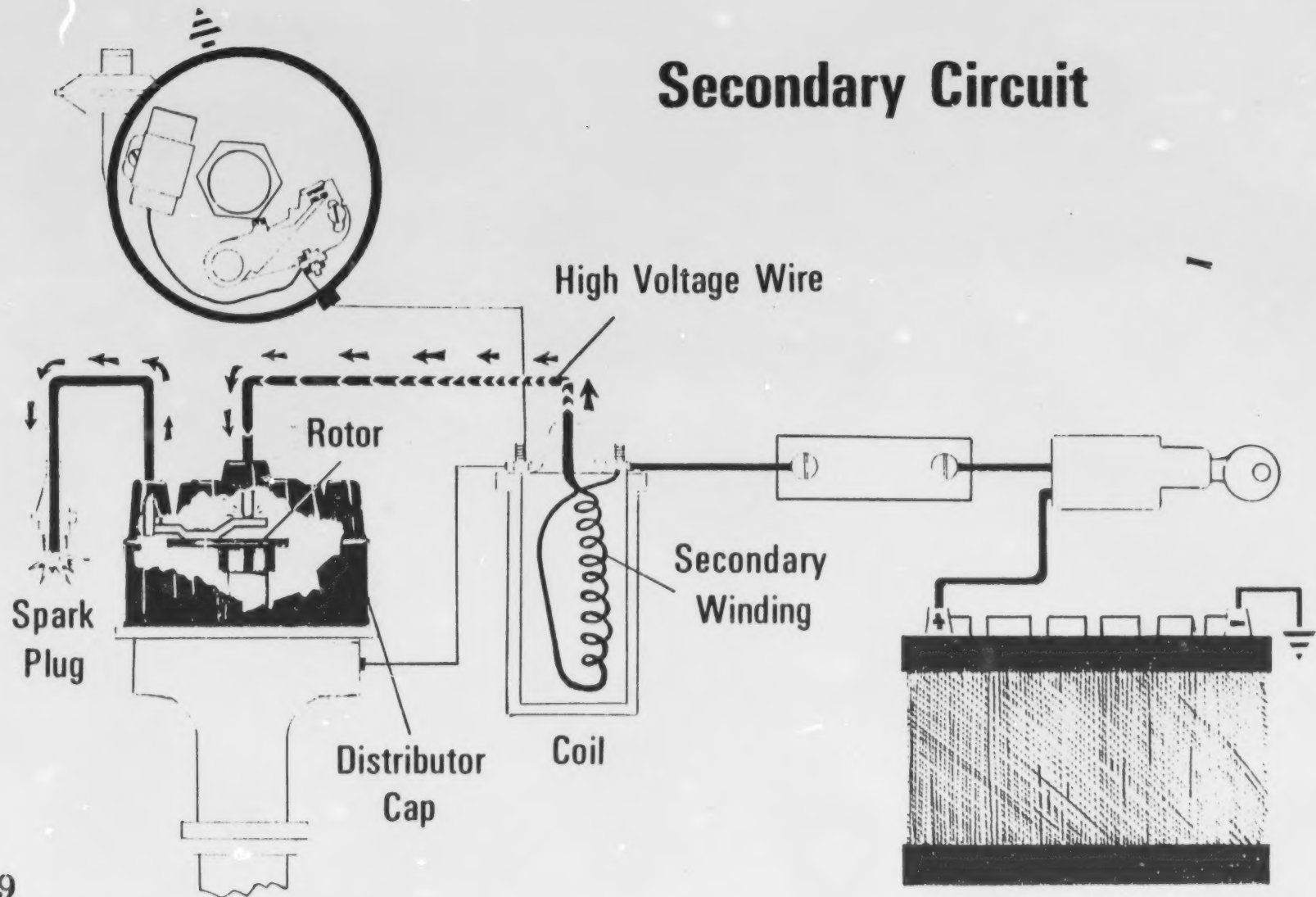
A. Engine may knock

B. Increased temperature within the cylinder

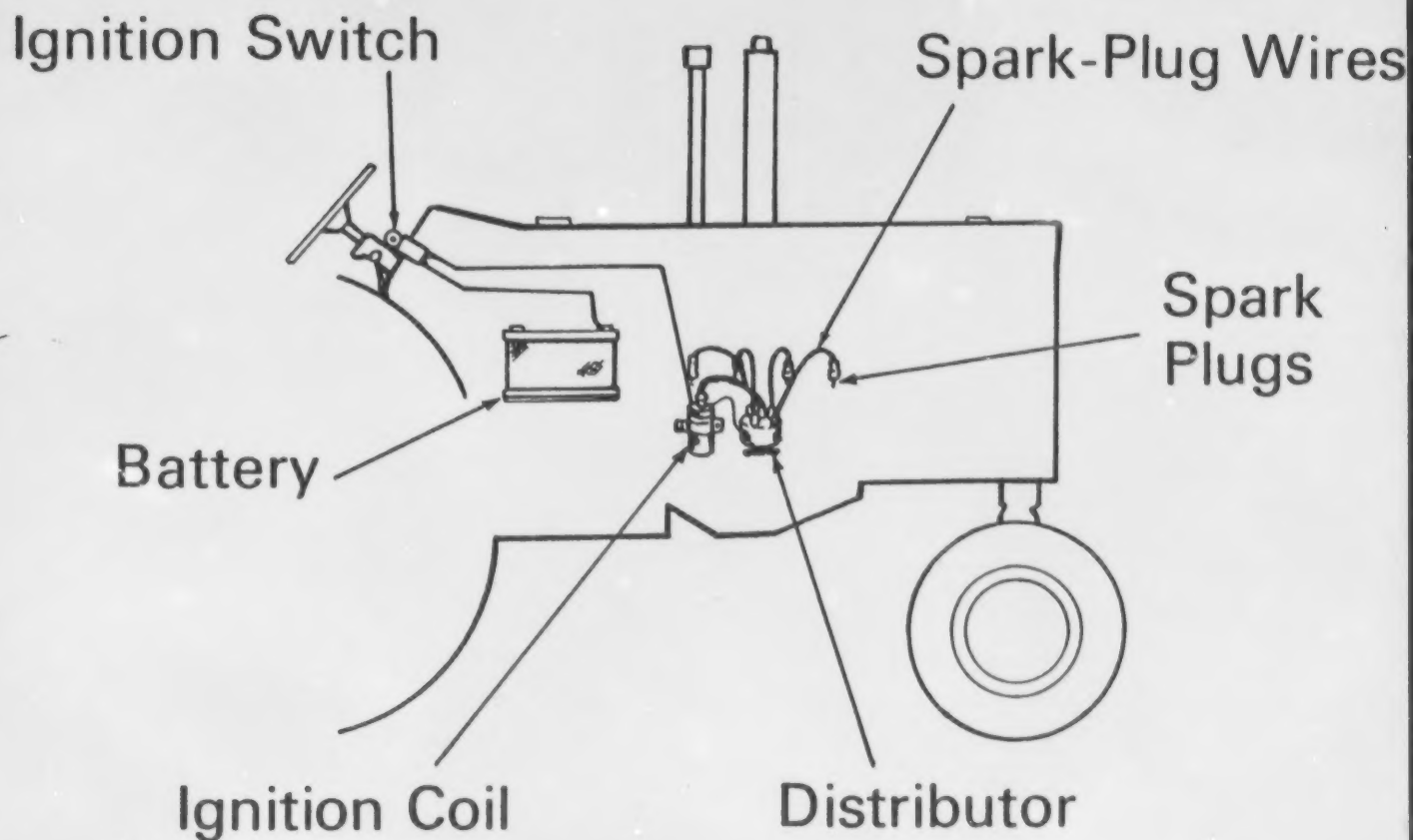
Primary Circuit



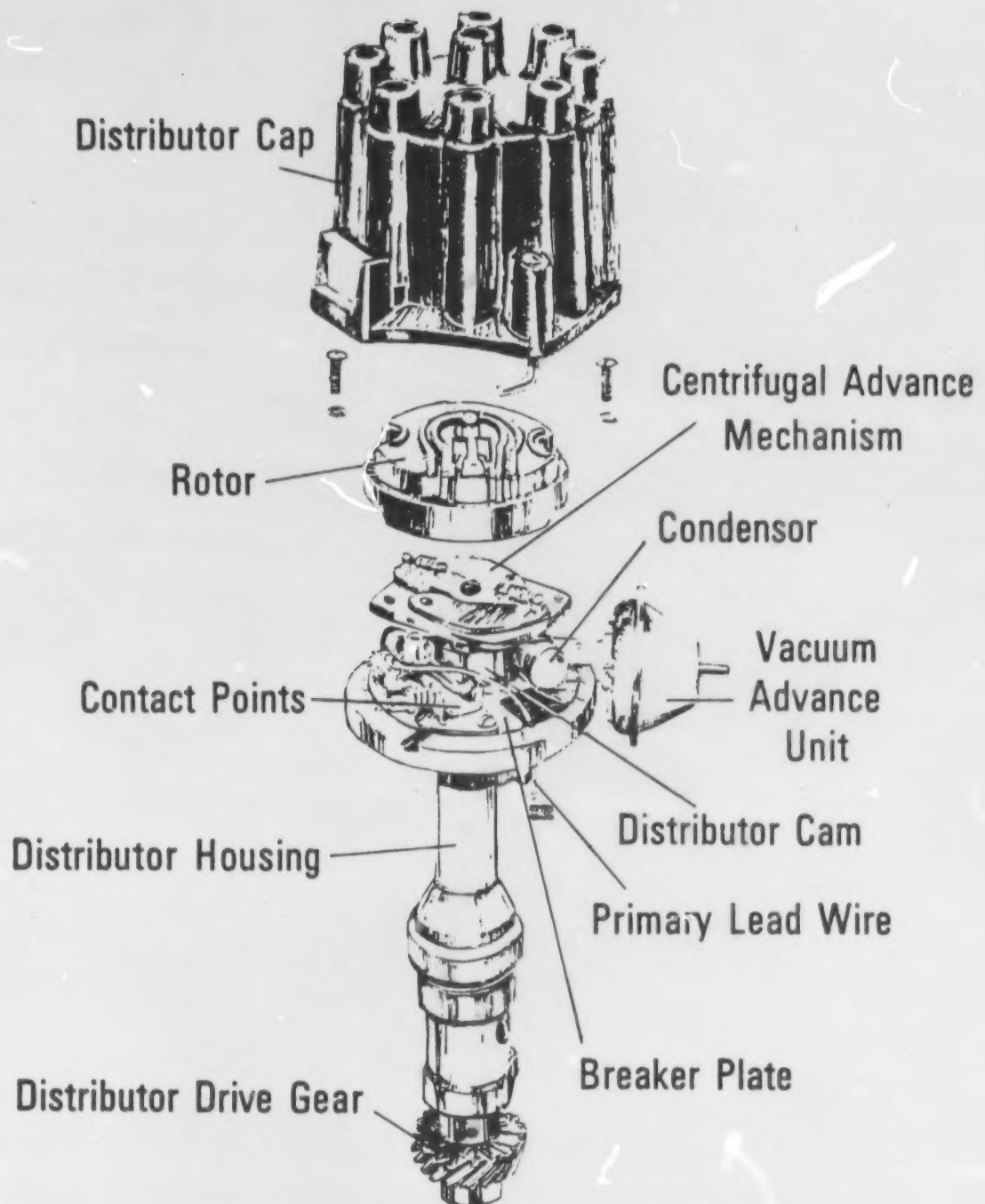
Secondary Circuit



Battery Powered Ignition System



Distributor Components



IGNITION SYSTEM
UNIT IX

JOB SHEET #1 - Check the Condition of the Distributor

I. Tools and materials needed

- A. Screwdriver
- B. End wrenches
- C. Ignition file
- D. Clean rags
- E. Small pan of kerosene or diesel fuel

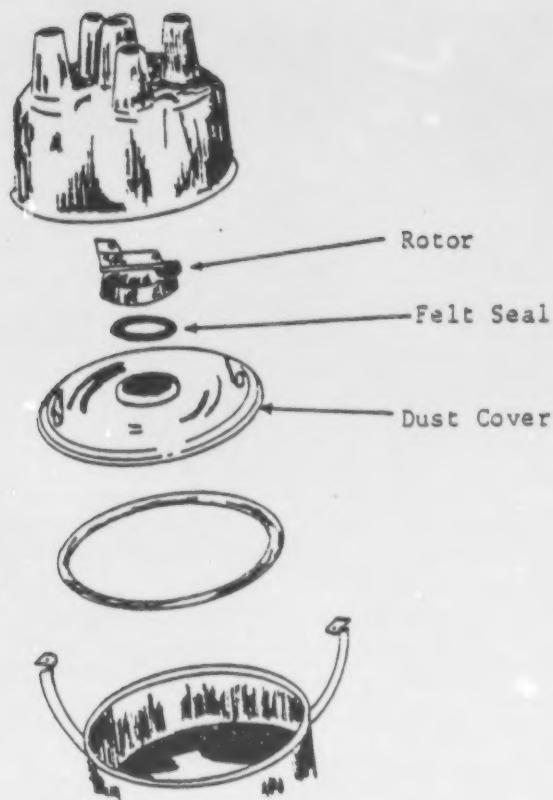
II. Procedure

- A. Remove dirt from outside surface of distributor and cap
(NOTE: Use a dry cloth or if necessary a small amount of diesel or kerosene. Do not use water, it may cause short circuiting.)
- B. Remove cap and clean inner surfaces - Leave wires connected
(NOTE: Use a clean dry cloth to remove carbon, dust, moisture or oil deposits.)
- C. Check distributor cap for chips or cracks
(NOTE: If cap is cracked, replace with a new one. Also check condition of carbon button in center of cap. If it shows excessive wear, chips, or cracks, get a new distributor cap.)

D. Remove distributor arm (rotor) and clean (Figure 1)

(NOTE: Pull the distributor arm or rotor straight up or out (if mounted horizontally) from the end of the shaft. Wipe the rotor arm clean with a dry cloth and inspect for cracks or excessive burning of the metal strip. If top of metal strip is badly burned, replace the old rotor with a new one.)

FIGURE 1



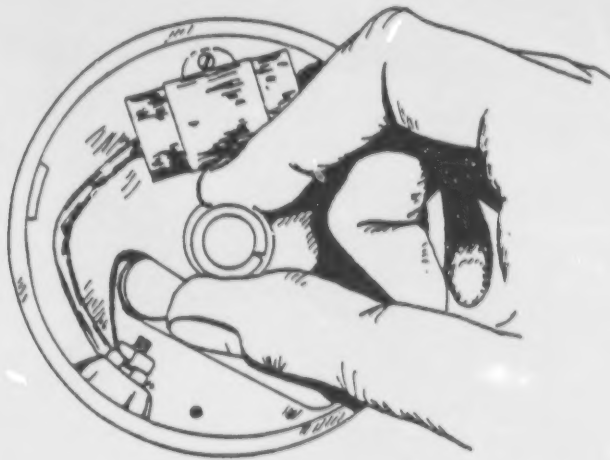
E. Remove dust cover, if one is used, and check condition of felt seal

(NOTE: If seal is worn, dirt may enter the breaker compartment and cause rapid wear of the cam lobes.)

F. Check the centrifugal-advance mechanism (Figure 2)

(NOTE: Turn distributor shaft in direction of normal rotation. It should rotate freely for a short distance as the weights move outward. The springs should return it to the original position when released. If it does not work properly, have a service man check it.)

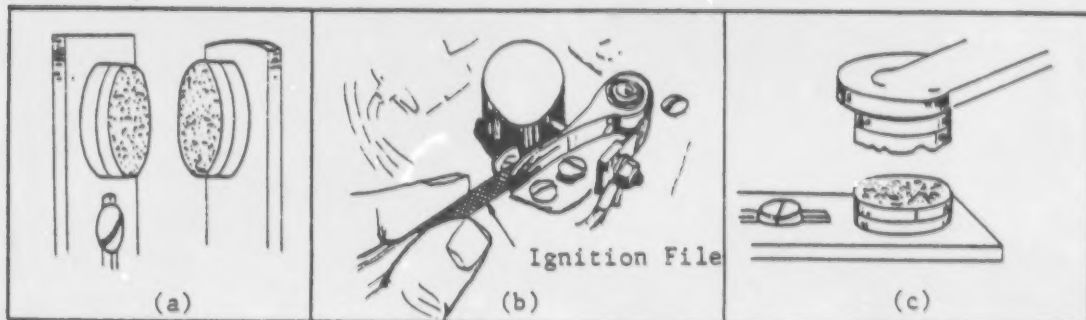
FIGURE 2



G. Check condition of breaker points

(NOTE: If the contact points are rough but show only slight pitting and metal deposits, smooth with an ignition file. The points do not need to be completely smooth with all pits removed. Blow out the dust after you have completed the filing. (Figure 3))

FIGURE 3



(a) Contact points that are slightly burned or pitted may be (b) smoothed with an ignition file. (c) Badly pitted points should be replaced with new ones.

Reassemble distributor in reverse order from the above listed steps.

IGNITION SYSTEM
UNIT IX

JOB SHEET #2 - Replace Breaker Points

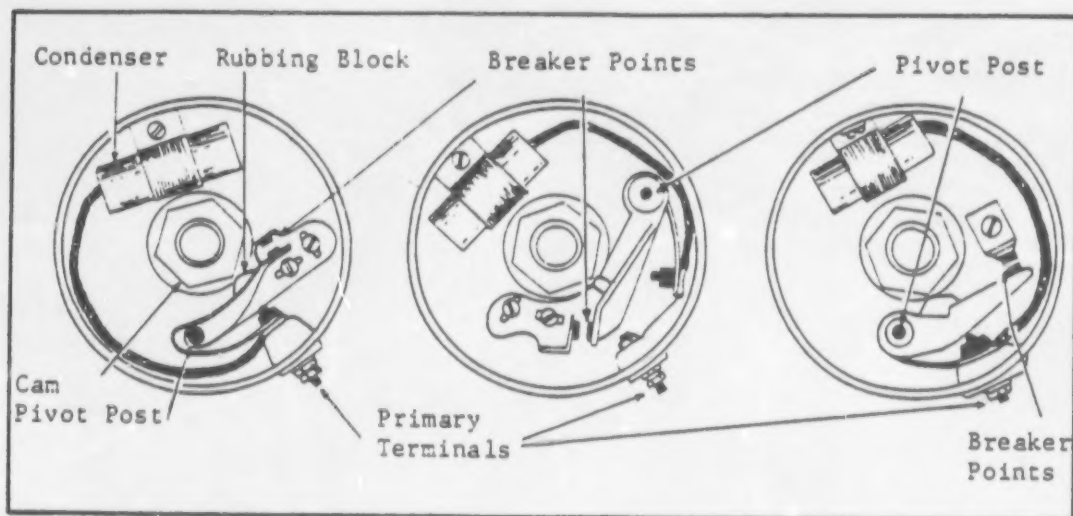
I. Tools and materials needed

- A. Screwdriver
- B. Multi-purpose grease
- C. Small amount of SAE-10 crankcase oil
- D. Clean rags

II. Procedure

- A. Remove breaker arm and spring (Figure 1)

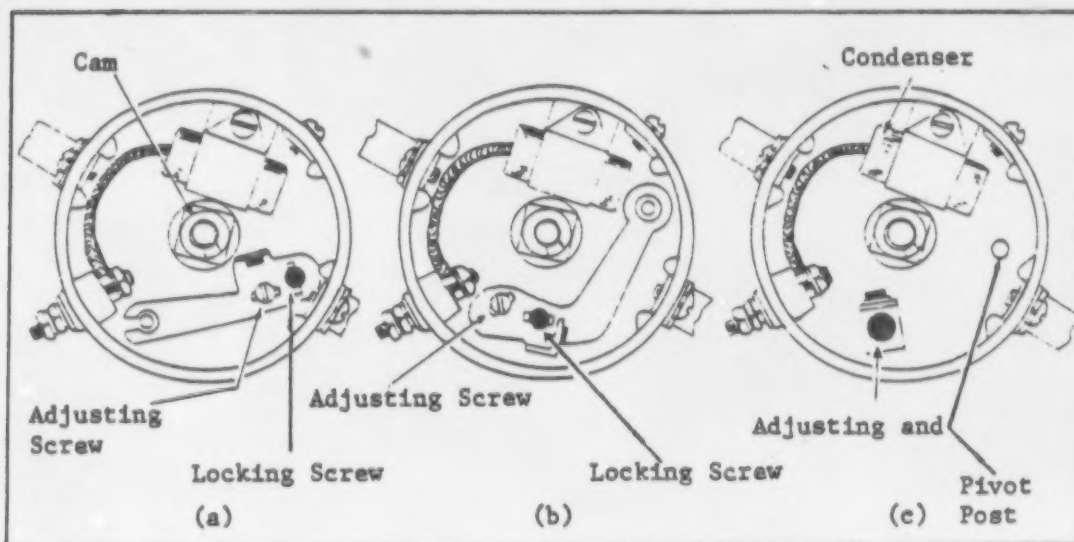
FIGURE 1



B. Remove stationary breaker point and bracket (Figure 2)

(NOTE: On most distributors one end of the breaker-point bracket is held by the same pivot pin that held the breaker arm. The other end is sometimes held by a locking screw (Figure 2a and 2b). The second screw is for adjusting the position of the points and is called an "eccentric screw" or "adjusting screw". On others, the bracket and breaker point are held by one screw (Figure 2c). With this type the hole in the bracket is slotted so the breaker point can be adjusted to the proper position.)

FIGURE 2



C. Clean, then lubricate cam with petroleum jelly or multi-purpose grease

(NOTE: Use only enough for a thin film on the cam lobes. This avoids getting it on the breaker points, causing them to burn. A very small amount greatly reduces wear on the rubbing block and cam.)

D. Install new points in reverse order

(NOTE: Apply a drop of SAE-10 crankcase oil around the contact point pivot post before installing new points. (Figure 2c) Be sure electrical connections are tight.)

IGNITION SYSTEM
UNIT IX

JOB SHEET #3 - Adjust Breaker Points

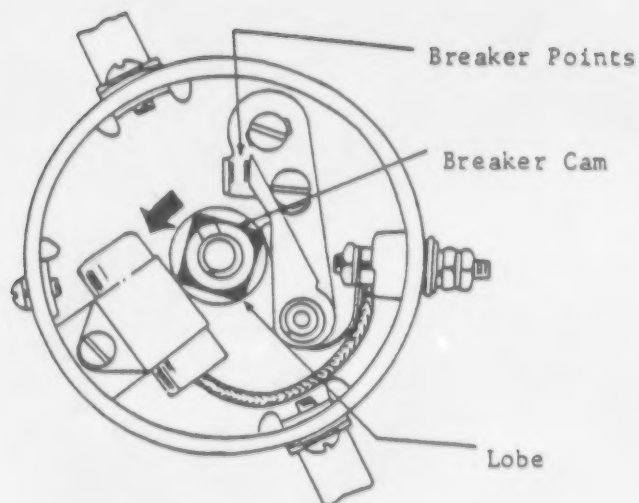
I. Tools and materials needed

- A. Screwdriver
- B. Thickness gage
- C. Clean rags
- D. Smooth paper strip

II. Procedure

- A. Turn engine until cam opens breaker points to widest position (Figure 1)

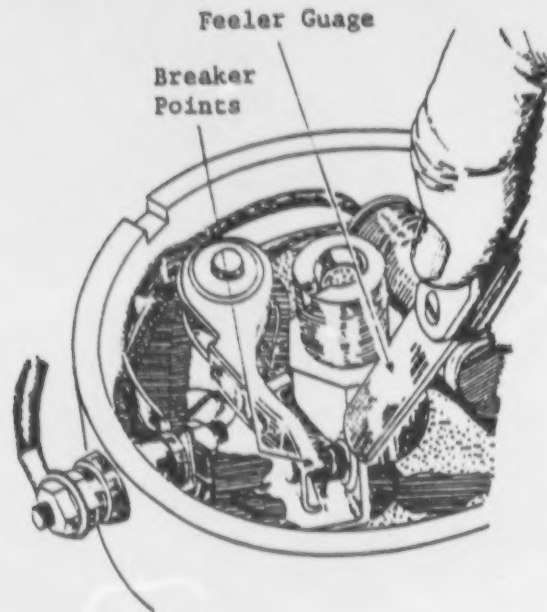
FIGURE 1



B. Check points for proper spacing (Figure 2)

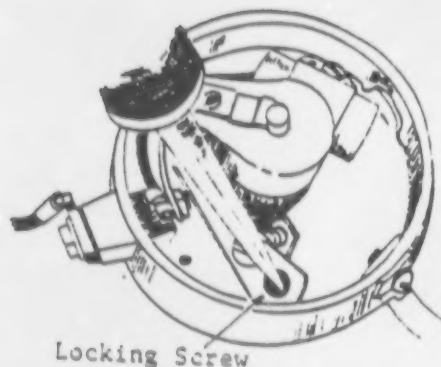
(NOTE: Use a feeler gauge of the thickness recommended for your tractor. This may vary from .010 to .028. The proper width gap is provided when there is a slight drag on the feeler gauge as you pull it between the contact points. If adjustment is needed, proceed with step C.)

FIGURE 2



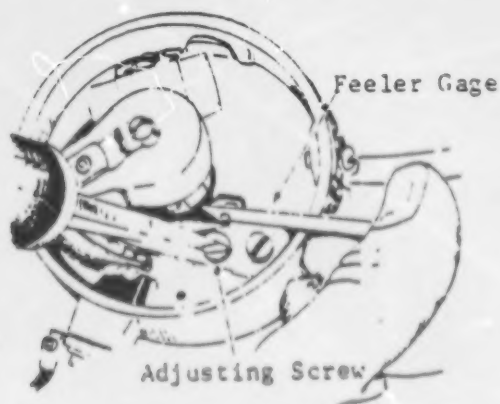
C. Loosen lock screw on bracket that provides adjustment (Figure 3)

FIGURE 3



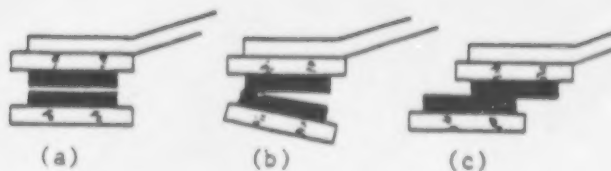
D. Adjust points for proper spacing and alignment (Figure 4)

FIGURE 4



(NOTE: Be sure the breaker-point faces fit together squarely.)
(Figure 5)

FIGURE 5



(a) Breaker points should fit together squarely to keep down wear.

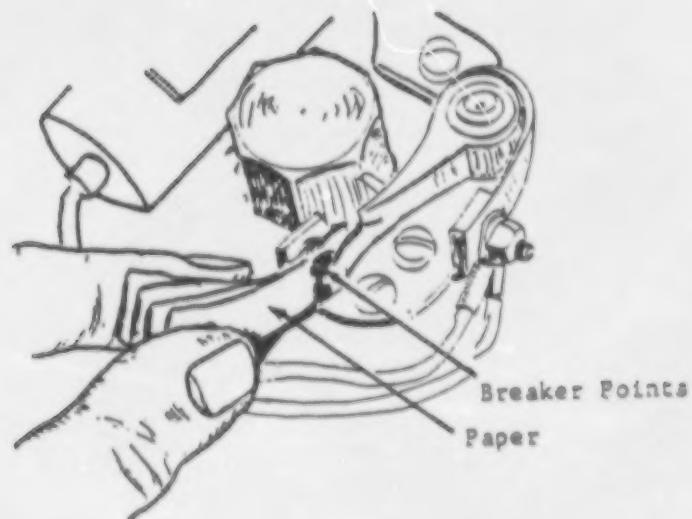
(b) and (c) Only partial contact causes arcing and uneven wear.

E. Lock breaker point in position with lock screw

F. Recheck gap between points and wipe points clean (Figure 6)

(NOTE: Run a strip of paper or a clean cloth between the contacts to remove any grease or dirt particles. A crisp dollar bill may be used to clean points.)

FIGURE 6



IGNITION SYSTEMS
UNIT IX

JOB SHEET #4 - Timing an Engine by the Breaker-Point Method

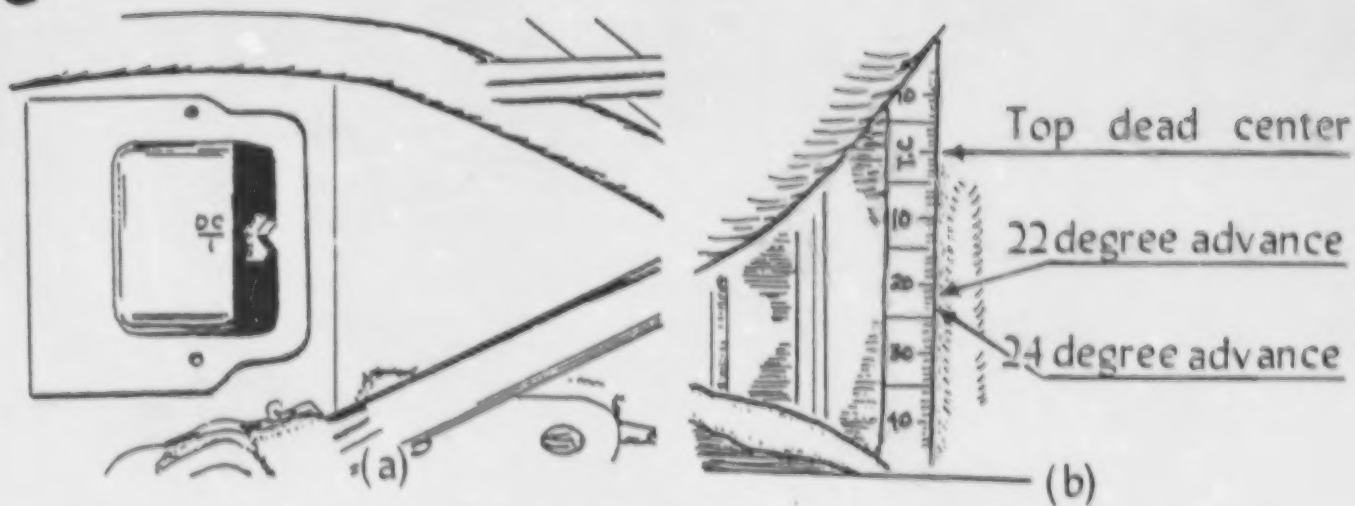
I. Tools and materials needed

- A. Set of box-end wrenches
- B. Screwdriver
- C. Piece of chalk
- D. Cleaning rags
- E. Paper towel
- F. Timing Light

II. Procedure

- A. Locate timing marks on flywheel or fan pulley (Figure 1)

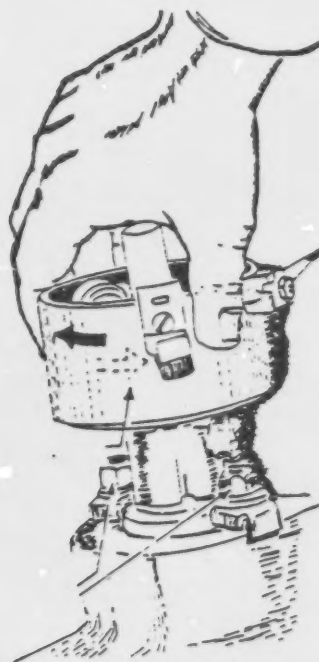
FIGURE 1



(a) One type of Flywheel Marking indicating top dead center position on No. 1 cylinder. (b) Markings on Fan-Belt Drive Pulley indicating top dead center and various advance positions.

- B. Loosen or remove spark plug from No. 1 cylinder
- C. Remove distributor cap
- D. Crank the engine until No. 1 cylinder starts compression stroke
(NOTE: Watch the way the distributor rotor is turning.)
- E. Continue to rotate slowly until proper marking appears on flywheel or fan-shaft pulley
(NOTE: Check operator's manual.)
- F. Remove rotor and dust cap
- G. Note if breaker points are just starting to open
(NOTE: If breaker points are just starting to open, the timing is satisfactory and you may now reassemble the distributor. If points are closed or just closing, engine is not timed correctly and the following procedure should be used.)
- H. Timing procedure:
 - 1. Loosen clamps that hold distributor to engine block
 - 2. Turn the distributor body slowly in the direction the rotor normally turns to make sure the points are completely closed. (See Figure 2)

FIGURE 2



3. Turn the distributor body slowing in opposite direction until points start to open

4. Tighten clamps that hold distributor body and reassemble distributor

(NOTE: The ignition should now be correctly timed.)

I. Tighten No. 1 spark plug and attach sparkplug wire

J. Start the engine to see if it operates satisfactorily

(NOTE: If the engine is not firing on all cylinders or is back-firing, probably some of the sparkplug wires came loose from the distributor and were replaced in the wrong openings of the distributor cap.)

K. If you removed a cover from over the timing hole, replace it.

IGNITION SYSTEM
UNIT IX

JOB SHEET #5 - Timing an Engine by the Timing-Light Method

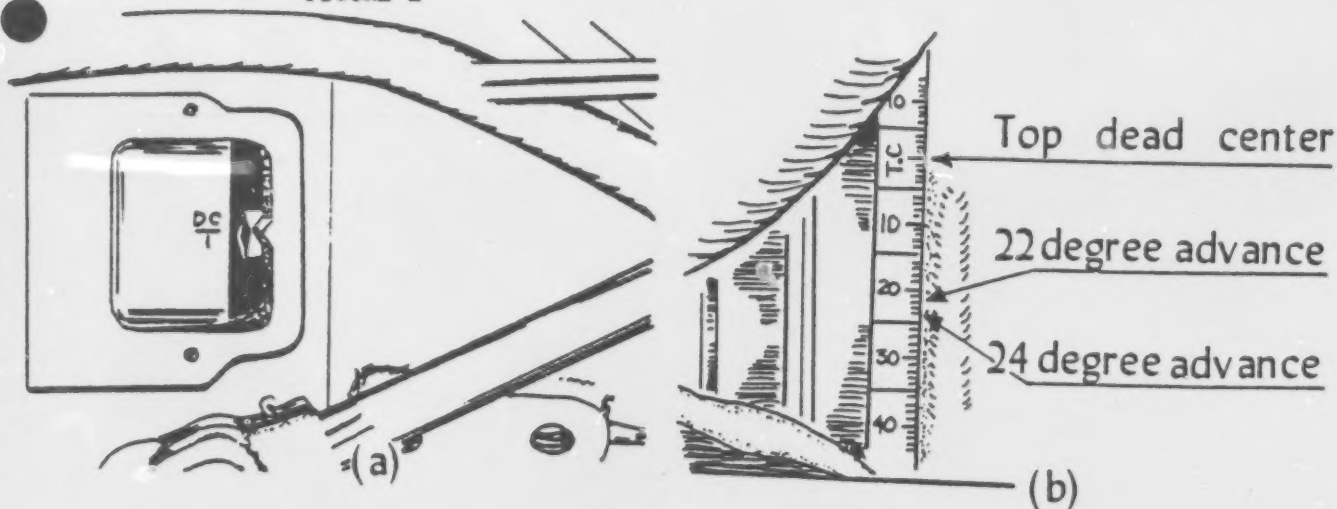
I. Tools and materials needed

- A. Set of box-end wrenches
- B. Screwdriver
- C. Piece of chalk
- D. Cleaning rags
- E. Paper towel
- F. Timing Light

II. Procedure

- A. Locate timing marks on flywheel or fan pulley (Figure 1)

FIGURE 1



(a) One type of FLYWHEEL MARKING indicating top dead center position on No. 1 cylinder. (b) Markings on FAN-BELT DRIVE PULLEY indicating top dead center and various advance positions.

- B. Connect timing light as recommended
- C. Determine from the operator's manual the timing mark to use

- D. Chalk the timing mark so it is easy to see
- E. Start engine and run at speed recommended in the operator's manual
- F. Direct timing light at markings of flywheel or on the fan pulley
(NOTE: Hold the timing light directly over the pointer. Holding it at an angle may cause timing to be too fast or too slow. When correctly timed, the proper timing mark will appear to stand directly in front of the pointer. If not, proceed with the following steps.)
- G. Loosen clamps that hold distributor
- H. Turn distributor body slightly until timing mark is opposite pointer
- I. Tighten distributor and remove timing light
- J. Replace cover over timing hole, if one was removed

IGNITION SYSTEM
UNIT IX

TEST

1. Match the terms on the right with the proper definition.

- | | |
|---|-----------------------------|
| _____ a. Carries low voltage from the battery to the primary side of the ignition coil (light wire) | 1. Battery |
| _____ b. Holds the coil and spark plug wires in a sequence and provides a cover for the distributor | 2. Ignition switch |
| _____ c. Regulate the timing of the high voltage circuit for best ignition during all speed and load conditions | 3. Resistance unit |
| _____ d. Contains the contact points and condensor; distributes the high voltage current from the coil to the proper cylinder | 4. Ignition coil |
| _____ e. Make and break the primary circuit to allow the coil to produce high voltage at the spark plugs | 5. Contact points |
| _____ f. Reduces voltage in the primary circuit to protect the contact points | 6. Condensor |
| _____ g. A source of electrical power | 7. Breaker cam |
| _____ h. Opens and closes the primary circuit from battery to the contact points | 8. Spark-advance mechanisms |
| _____ i. Transforms low voltage into high voltage necessary to jump the spark plug gap | 9. Rotor |
| _____ j. Stores extra current as the contact points open to prevent arcing and burning | 10. Distributor cap |
| | 11. spark plug |
| | 12. Primary ignition wire |
| | 13. Secondary ignition wire |
| | 14. Distributor |

- ___ k. Opens and closes the contact
- ___ l. Takes the high voltage current from the coil and directs it to the correct cylinder
- ___ m. Provides a spark gap inside the engine cylinder to ignite the fuel air mixture
- ___ n. Carries high voltage from the secondary side of the coil to the spark plug (heavily insulated wire)

2. Explain in writing the purpose of the ignition system.

3. Select from the list below the components of the primary and secondary ignition circuits. Place an "X" by the correct components

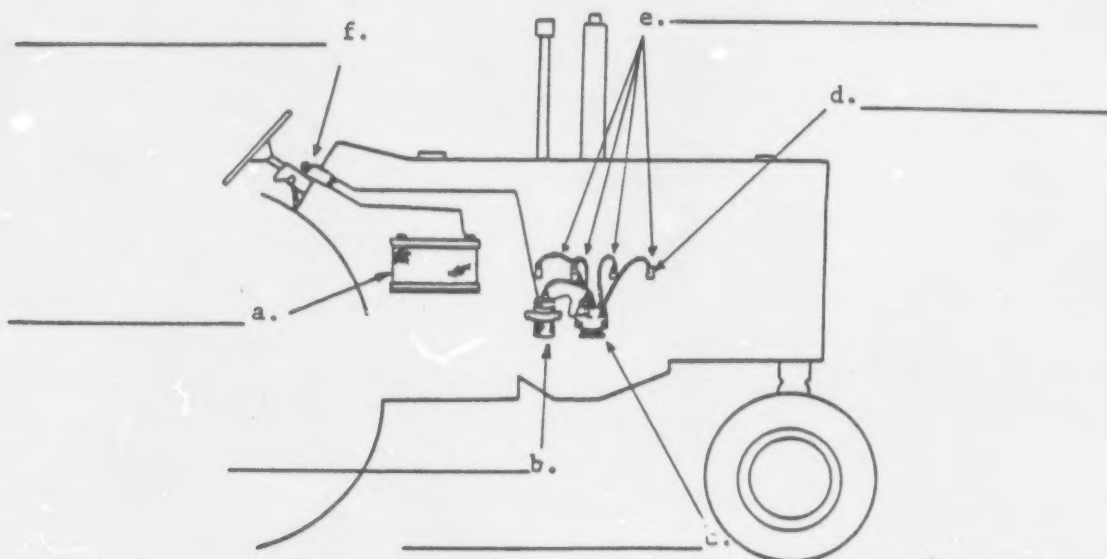
a. Primary--Low voltage circuit

- ___ 1) Battery
- ___ 2) Rotor
- ___ 3) Ignition switch
- ___ 4) Spark plug
- ___ 5) Contact points
- ___ 6) Condensor

b. Secondary--High voltage circuit

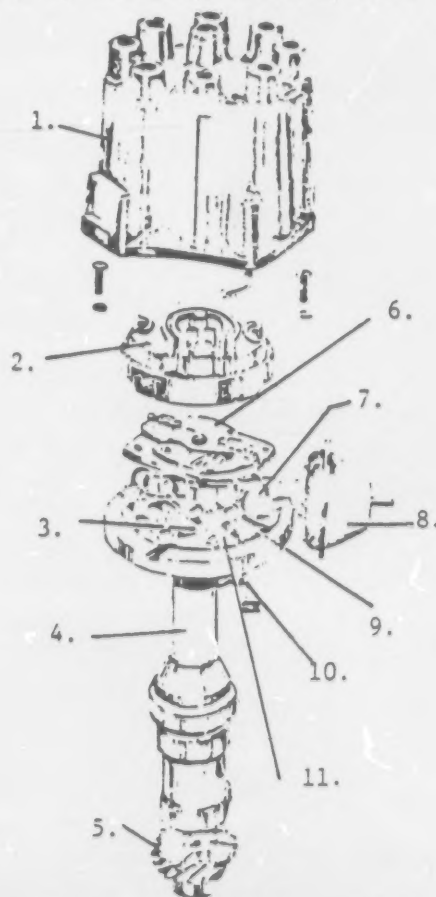
- ___ 1) Secondary winding of the coil
- ___ 2) Distributor cap
- ___ 3) Resistance unit
- ___ 4) Rotor

4. Identify the parts of a battery-powered ignition system.



5. Identify the components of the distributor by matching the component to the illustration on the right.

- ___ a. Distributor cap
- ___ b. Rotor
- ___ c. Centrifugal advance mechanism
- ___ d. Condensor
- ___ e. Vacuum advance
- ___ f. Breaker plate
- ___ g. Distributor cam
- ___ h. Contact points
- ___ i. Distributor housing
- ___ j. Primary lead wire
- ___ k. Distributor drive gear



6. List two reasons for badly burned points.
 - a.
 - b.
7. Name two methods of timing an engine.
 - a.
 - b.
8. List two reasons why engine timing is important.
 - a.
 - b.
9. Name three indications of timing being too early.
 - a.
 - b.
 - c.
10. Name two indications of timing being too late.
 - a.
 - b.
11. Demonstrate the ability to:
 - a. Check the condition of the distributor.
 - b. Replace breaker points.
 - c. Adjust breaker points.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)
 - d. Time an engine by the breaker-point method.
 - e. Time an engine by the timing-light method.

IGNITION SYSTEM
UNIT IX

ANSWERS TO TEST

1.
 - a. 12
 - b. 10
 - c. 8
 - d. 14
 - e. 5
 - f. 3
 - g. 1
 - h. 2
 - i. 4
 - j. 6
 - k. 7
 - l. 9
 - m. 11
 - n. 13
2. To produce high voltage current to ignite the fuel air mixture in the engine cylinders.
3.
 - a.
 - 1)
 - 3)
 - 5)
 - 6)
 - b.
 - 1)
 - 2)
 - 4)
4.
 - a. Battery
 - b. Ignition coil
 - c. Distributor
 - d. Spark plugs

- e. Spark-plug wires
- f. Ignition switch

- 5. a. 1
- b. 2
- c. 6
- d. 7
- e. 8
- f. 11
- g. 9
- h. 3
- i. 4
- j. 10
- k. 5

- 6. Any two of the following:

- a. Oil or foreign material on the contact surfaces
- b. A contact-point gap adjustment that is either too wide, too close, or points that are out of alignment
- c. A defective condensor

- 7. a. The breaker-point method
- b. The timing-light method

- 8. a. Increase horsepower
- b. Decrease fuel consumption

- 9. Any three of the following:

- a. Retarded spark causes late timing
- b. Exhaust gases escape while they are still quite hot
- c. Wastes power
- d. Increase in exhaust gas temperature
- e. Warped valves

10.
 - a. Engine may knock
 - b. Increased temperature within the cylinder
11. Performance skills will be evaluated to the satisfaction of the instructor.

ARC WELDING UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to select kinds of arc welders and equipment needed and list safety precautions observed in arc welding. He should also be able to strike an arc, run a bead, and construct a butt weld. This knowledge will be evidenced through actual demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with arc welding to the correct definition.
2. List five safety precautions used in arc welding.
3. List two kinds of arc welders.
4. Select from a list common equipment used in arc welding.
5. List four types of electrodes.
6. Select from a list the two most common sizes of electrodes used in agricultural mechanics.
7. Identify the meaning of the numbers in the electrode classification system.
8. Name two methods of coating electrodes.
9. List three purposes of electrode coating.
10. Describe the effect of raising and lowering the arc welding current.
11. Name two methods of establishing an arc.
12. Select from a list characteristics of proper arc length.
13. Label the parts of a drawing associated with the welding process.
14. Identify three kinds of welds.
15. Identify five types of weld joints.
16. List four welding positions.
17. List four reasons for poor welds.
18. Name the five essentials for a proper welding procedure.
19. Demonstrate the ability to:
 - a. Start, stop, and restart a bead.
 - b. Construct a pad weld.
 - c. Construct a butt weld.

ARC WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in job sheets.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheet and take notes.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
 - 1. TM 1 - The Welding Circuits
 - 2. TM 2 - AC Arc Welder
 - 3. TM 3 - DC Arc Welder
 - 4. TM 4 - The Welding Hood
 - 5. TM 5 - Electrode Types
 - 6. TM 6 - AWS Classification of Electrodes
 - 7. TM 7 - Striking the Arc
 - 8. TM 8 - Welding Process
 - 9. TM 9 - Kinds of Welds
 - 10. TM 10 - Types of Weld Joints

11. TM 11 - Welding Positions
12. TM 12 - Build-up Operation
13. TM 13 - Depositing Continuous Beads
14. TM 14 - Bead Appearances

D. Job Sheets

1. Job Sheet #1 - Start, Stop, and Restart a Bead
2. Job Sheet #2 - Construct a Pad Weld
3. Job Sheet #3 - Construct a Butt Weld

E. Test

F. Answers to test

II. References:

- A. Jones, M.M. Shopwork on the Farm. New York: McGraw-Hill Company, 1955.
- B. Phipps, Lloyd J. Mechanics in Agriculture. Danville, Illinois: Interstate Printers and Publishers, Inc., 1967.
- C. Kugler, Harold L. ARC Welding Lessons for School and Farm Shop. Cleveland, Ohio: The James F. Lincoln Arc Welding Foundation, 1964.
- D. Hallenberg, A.H. How to Teach Arc Welding in Farm Mechanics. Cleveland, Ohio: The James F. Lincoln Arc Welding Foundation, 1958.
- E. Hobart Welding School Workbook. Troy, Ohio: Hobart Brothers Technical Center.
- F. Farm Welding, Cooperative Extension Service, Kansas State University, Manhattan, Kansas 66506. XE-E9.

ARC WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

- A. Arc - Flow of current across a narrow gap
- B. Base metal - Metal to be welded
- C. Bead weld - Made by one pass of the electrode
- D. Bevel - Type of edge preparation
- E. Butt joint - Weld between two metal parts on the same plane
- F. Crater - Depression at the end of weld
- G. Electrode - Metal rod which conducts a current from the electrode holder to the base metal
- H. Welding - Joining of two or more pieces of metal together by the fusion process
(NOTE: In arc welding, heat is produced by the electric arc.)
- I. AWS - American Welding Society
- J. Arc Length - The distance from the end of the electrode core to the bottom of the crater
- K. Bead - A continuous deposit of weld material
- L. Chipping - Removal of slag by using light blow applied with a special hammer
- M. Electrode coating - Extruded coating on electrode core that stabilizes and directs the arc, and produces a gaseous shield around the arc
- N. Ground - Electrical connection between work and the welding circuit
- O. Open Circuit Voltage - Voltage in the welding circuit when the welder is on but arc has not been established
- P. Padding - Building up a surface by using a series of overlapping beads
- Q. Peening - Stretching the weld area by hammering and reducing stresses
- R. Penetration - Depth of fusion produced by the weld
- S. Polarity - Relates to DC welding and indicates direction of flow of welding current in the circuit
- T. Slag - Deposit of impurities and materials from the electrode coating which solidify on top of the weld bead as it cools

- U. Spatter - Hot slag of weld metal which is deposited outside or adjacent to the weld bead
- V. Striking - The process of establishing the arc by scratching or tapping the electrode point against the base metal
- W. Tack Weld - Small or short welds used to hold base metal parts in place prior to welding
- X. Tow of Crater - The foremost part of the crater located in the direction of welding

II. Safety precautions in arc welding

- A. Never look at the arc with the naked eye
- B. Use a head or face shield that is in good condition
- C. Wear suitable clothing to protect all parts of the body
 - Examples: 1. Long sleeved shirt
 - 2. Leather gloves
 - 3. Collar buttoned
 - 4. Cuffs turned down
 - 5. High topped shoes or boots
- D. Do not strike an arc or weld until you are sure those in the vicinity have protective equipment or will look in the other direction

(NOTE: Yell "cover" before striking an arc.)
- E. Do not weld around combustible or flammable materials
- F. Do not pick up hot metal
- G. Do not weld in confined places without ventilation
- H. Always open main switch or disconnect plug when checking over a welder
- I. Do not leave electrode holder on welding table or in contact with grounded metal
- J. Do not use worn or frayed cables
- K. Stand on dry footing when welding
- L. Keep area around welder clean
- M. Keep tools and metals in proper location

III. Kinds of arc welders (Transparency 1)

- A. AC - (Alternating current) Welder current alternates direction 120 times per second (Transparency 2)
- B. DC - (Direct current) Welder current flows in the same direction (Transparency 3)
- C. TIG - (Tungsten Inert Gas) Welder may use either AC or DC with a nonconsumable tungsten electrode and an inert shielding gas

- D. MIG - (Metal Inert Gas) May use AC or DC with a base wire filler material that is fed automatically into weld; also has an inert shielding gas

IV. Common arc welding equipment

- A. Welder
- B. Electrode holder with lead
- C. Ground clamp with lead
- D. Shield or helmet (Transparency 4)
- E. Gloves
- F. Chipping hammer
- G. Safety goggles
- H. Wire brush
- I. Electrodes

V. Types of electrodes (Transparency 5)

- A. Mild steel
- B. High carbon steel
- C. Hard surfacing
- D. Allcys - Special purpose

VI. Common sizes of electrodes used in agricultural mechanics

- A. 1/8"
- B. 5/32"

(NOTE: Sizes of electrodes range from 1/16" to 3/8". Electrode size is determined by the diameter of the wire.)

VII. Meaning of numbers in the electrode classification system (Transparency 6)

- A. E—Arc welding electrode
- B. 60—Tensile strength in thousand of pounds per square inch
- C. 1—Position to be used
- D. 1—Special characteristics

VIII. Methods of coating electrodes

- A. Wrapping
- B. Dipping

(NOTE: Electrodes are dipped into a liquid flux solution.)

C. Extruding

(NOTE: This is the most common method.)

IX. Purposes of electrode coating

- A. Stabilizes the arc
- B. Shields molten puddle from air
- C. Floats impurities out of puddle
- D. Forms slag and slows cooling
- E. Increases speed and improves quality of weld

X. Effect of raising and lowering current

- A. Raising current - Produces more heat
- B. Lowering current - Produces less heat

(NOTE: On thicker metals more heat is necessary in order to get penetration.)

XI. Methods of establishing an arc (Transparency 7)

- A. Scratching (similar to striking a match)
- B. Tapping

XII. Characteristics of proper arc length

- A. End of electrode is the same distance from the base metal as the diameter of electrode
Example: 1/8" electrode--arc length 1/8"
- B. Correct arc length makes a steady hum of the welder and a "frying" sound at the arc

XIII. Parts of the welding process (Transparency 8)

- A. Electrode
- B. Wire core
- C. Coating (flux)
- D. Arc
- E. Gaseous shield
- F. Weld
- G. Slag
- H. Heat lines
- I. Base metal
- J. Penetration

- K. Crater
- L. 15 degrees-30 degrees
- M. Direction of travel

XIV. Kinds of welds (Transparency 9)

- A. Fillet
- B. Groove
- C. Bead

XV. Types of weld joints (Transparency 10)

- A. Edge joint
- B. Butt joint
- C. Corner joint
- D. T joint
- E. Lap joint

XVI. Weld positions (Transparency 11)

- A. Flat
- B. Vertical
- C. Overhead
- D. Horizontal

XVII. Reasons for poor welds

- A. Machine adjustment too hot or too cold
- B. Electrode size too large or too small
- C. Improper movement of electrode
- D. Improper angle of holding electrode
- E. Improper base metal preparation
- F. Arc length too long or too short

XVIII. The five essentials for proper welding procedure

- A. Select Proper Electrode - Size and Type
 - Consider - 1. Type joint to weld
 - 2. Position of weld
 - 3. Joint preparation
 - 4. Mass of work
- B. Select Correct Amperage

- Consider -
1. Size of electrode
 2. Type of electrode
 3. Kind of metal to be welded
 4. Thickness and size of metal to be welded
 5. Position of weld
 6. Joint type to be welded
 7. Joint preparation and fit-up

C. Use correct Travel Speed

- Consider -
1. Affects size of bead and depth of penetration.
 2. Excess buildup increases costs
 3. Excess buildup causes distortion
 4. Speed can be regulated by controlling puddling size. 1/8" electrode use a 1/4" puddle

D. Position the Electrode Correctly

1. Use correct ARC length
 - a) Distance from metal core to bottom of crater
 - b) A steady frying and crackling sound indicates correct length
 - c) Arc length as a general rule should be approximately equal to wire core diameter of electrode
 - d) Effect of too long and too short an arc - see TM 14
2. Use correct angle of electrode
 - a) Based on type of weld to be made - Butt (groove) or fillet and position of weld - flat, vertical or overhead
 - b) Improper electrode angles cause
 - 1) Poor penetration
 - 2) Under cutting
 - 3) Slag inclusions
 - c) When doing butt (groove) welds in the flat position:
 - 1) The puddle should be circular in shape
 - 2) Lean electrode 15-25 in direction of travel
 - 3) Angle to side - varies as to thickness of pieces of metal to be joined. 90° if pieces are of equal thickness

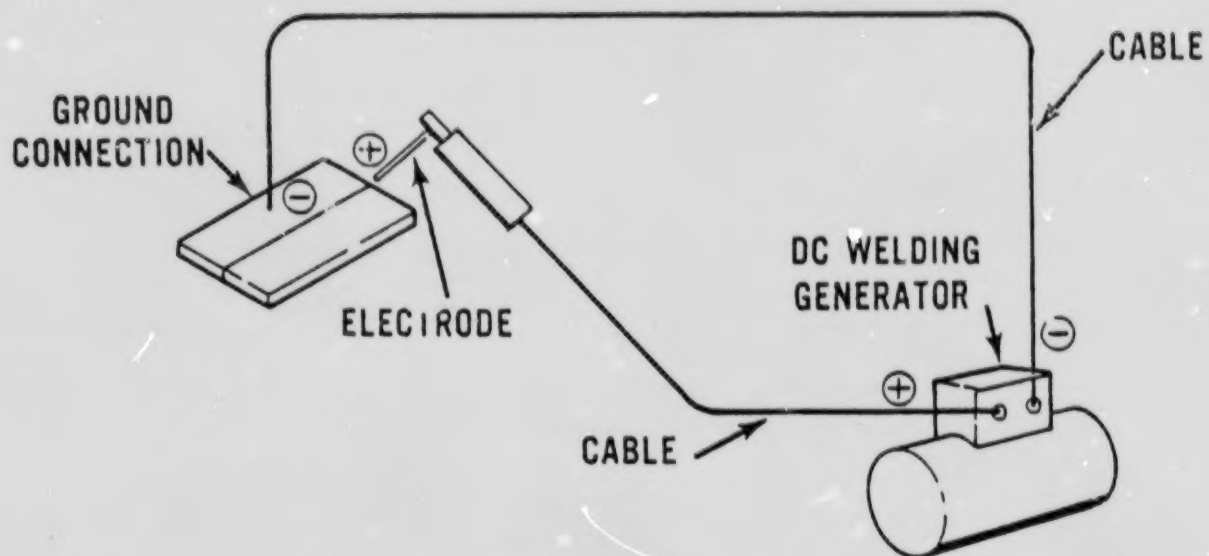
E. Use proper joint preparation and positioning

1. Common joint preparation for butt (groove) welds are:

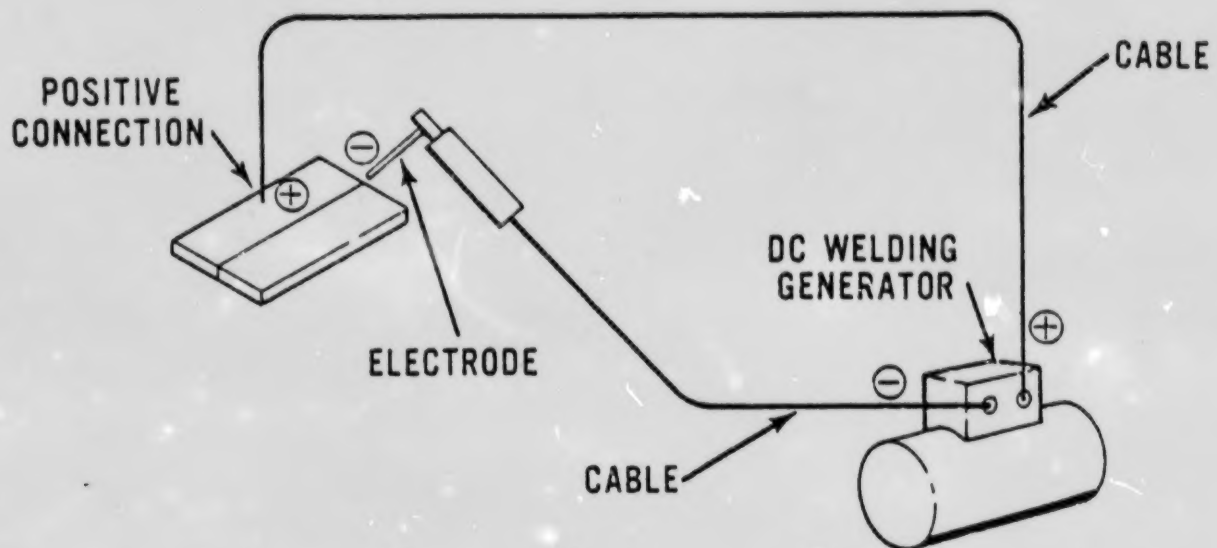
- a) Square 
- b) Vee Bevel 
- c) Half Vee Bevel 
- d) U Bevel 
- e) J Bevel 
- f) Flare Vee Bevel 
- g) Flare Bevel 

- 2. Joint preparation is done to provide for maximum penetration with a minimum of heat and distortion
- 3. Thinner metal pieces may be spaced rather than shaped to give the desired effect

THE WELDING CIRCUIT

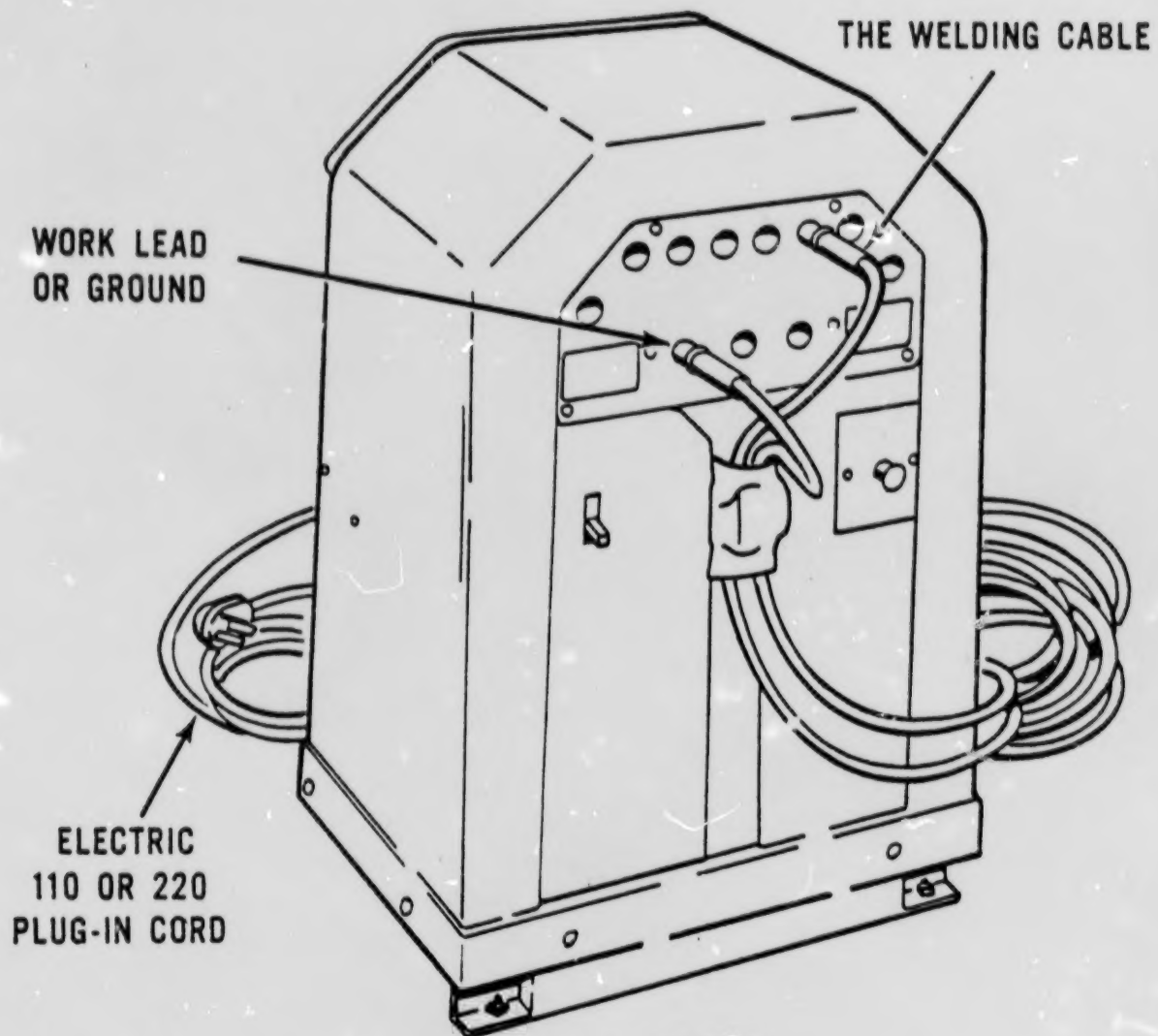


POSITIVE OR REVERSE POLARITY

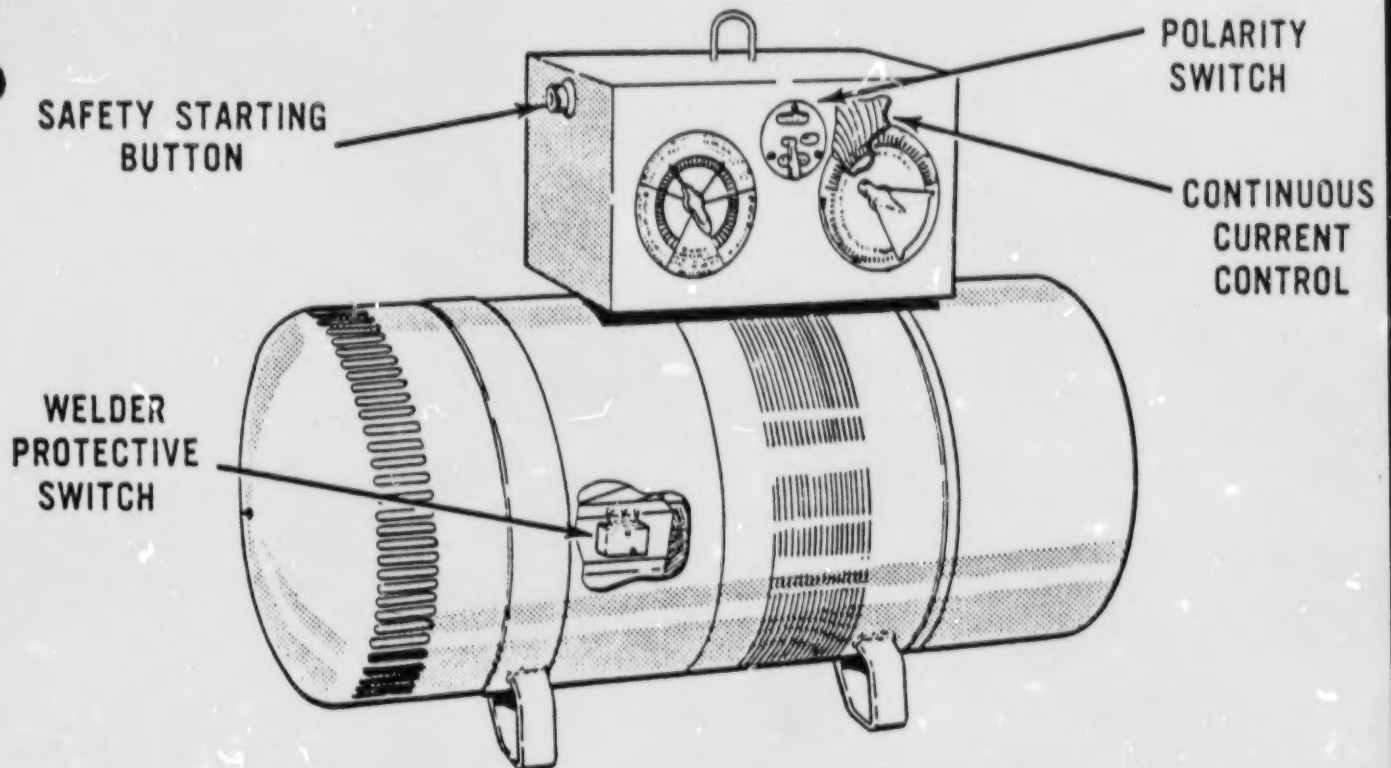


NEGATIVE OR STRAIGHT POLARITY

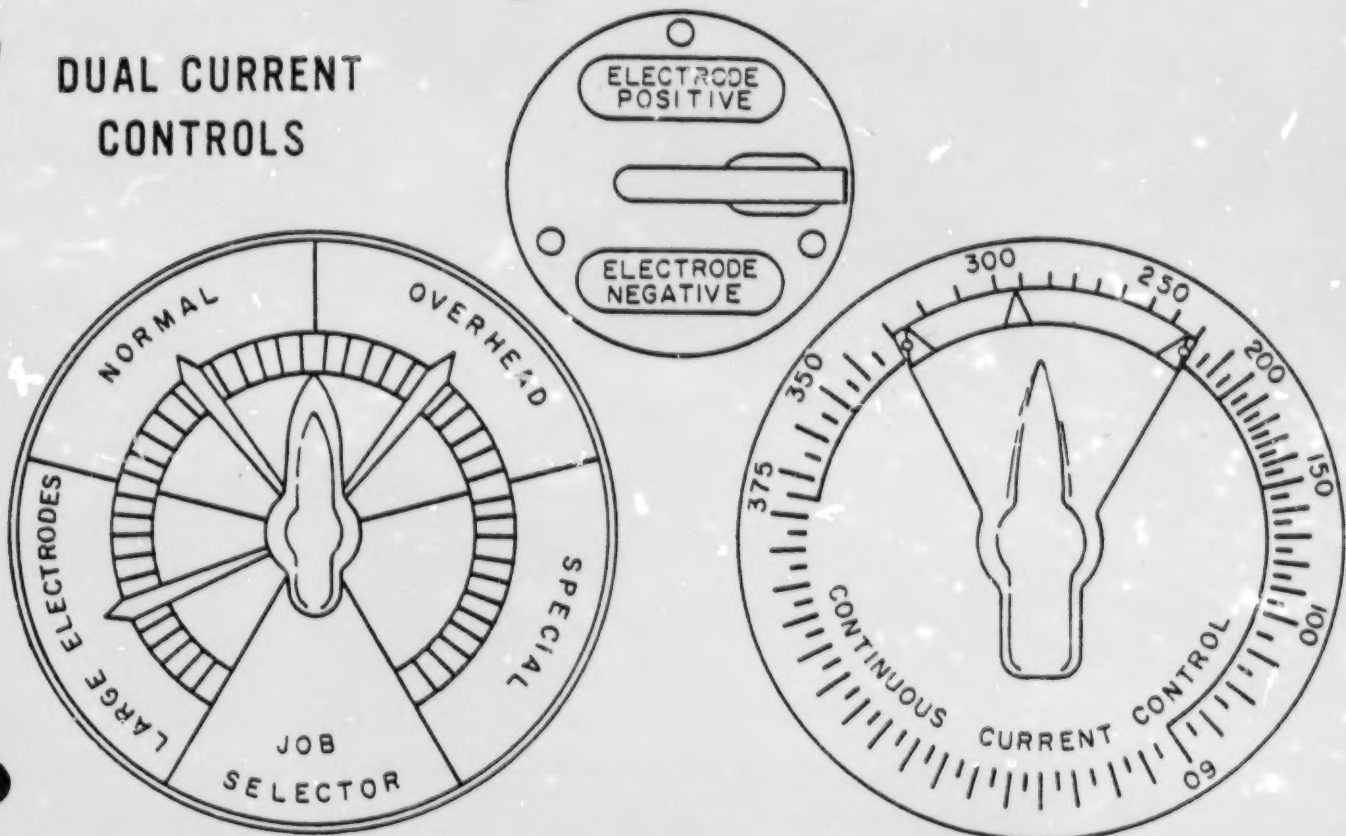
A-C ARC MACHINE



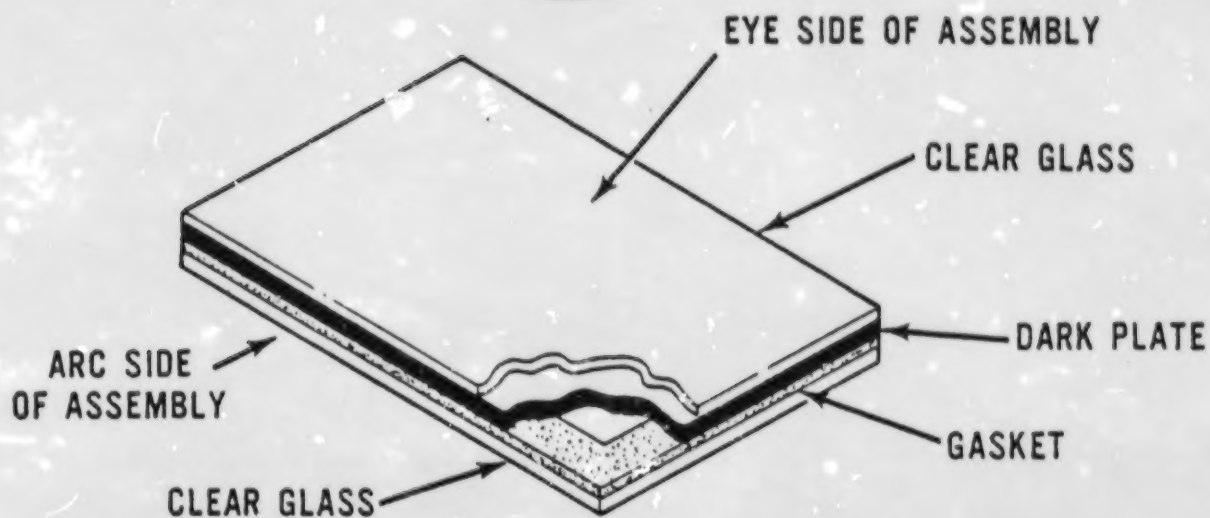
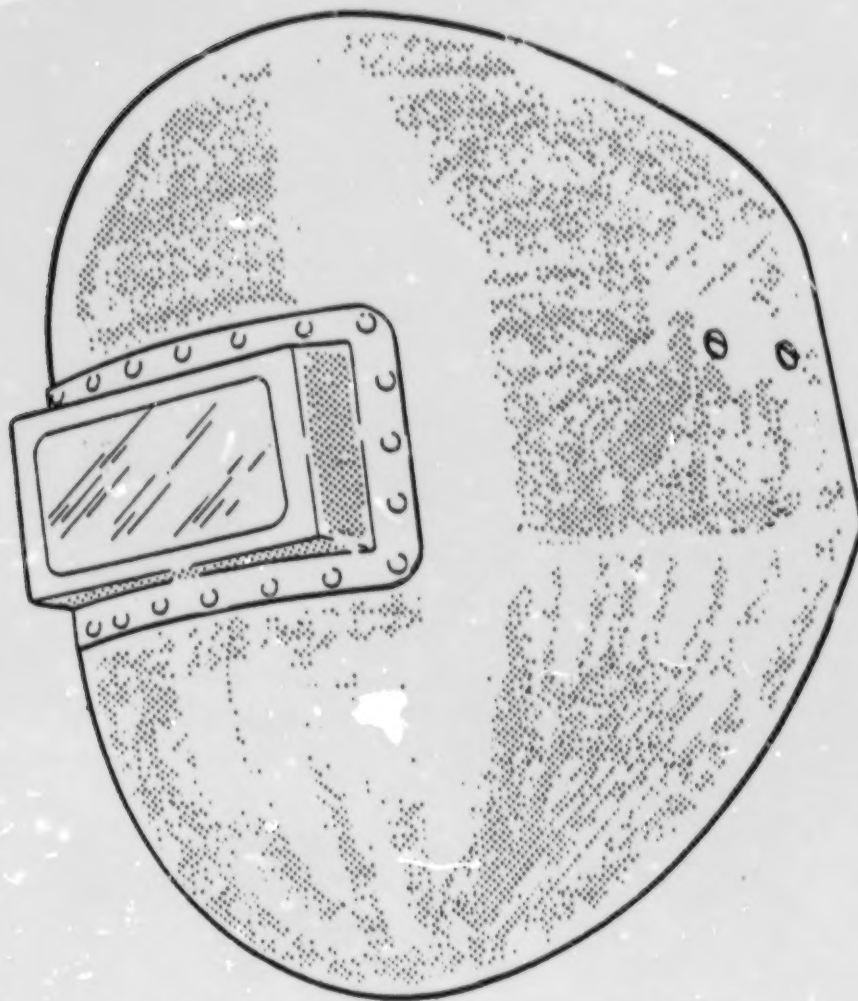
D-C ARC MACHINE



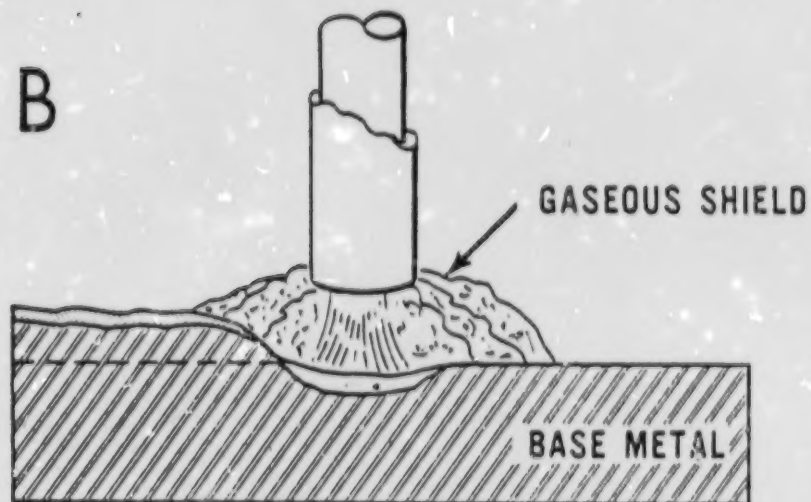
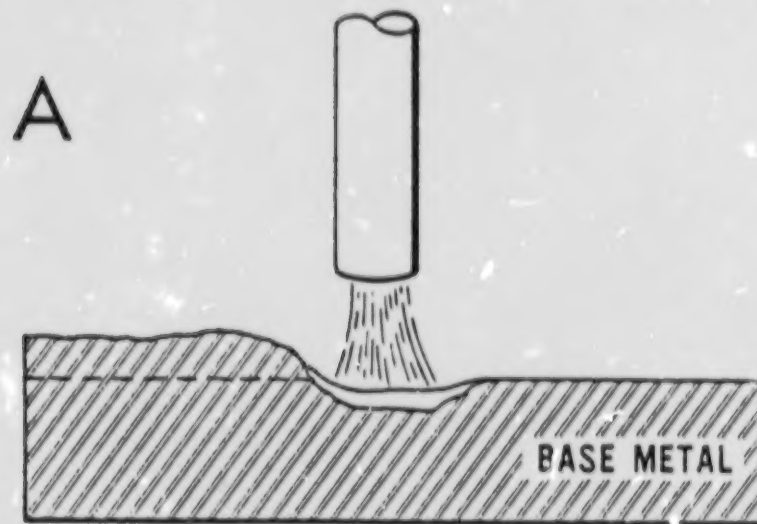
DUAL CURRENT CONTROLS



THE WELDING HOOD



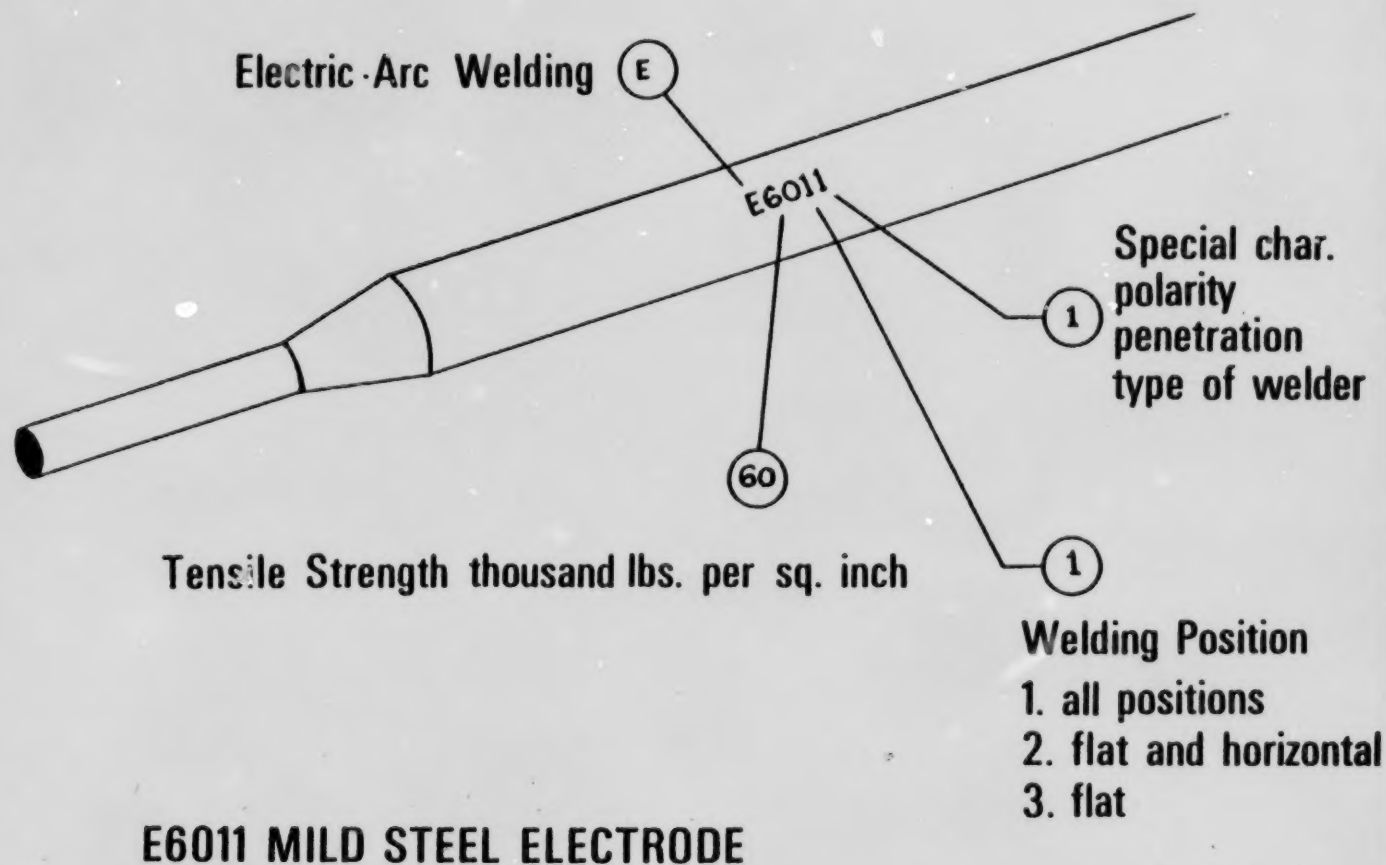
ELECTRODE TYPES



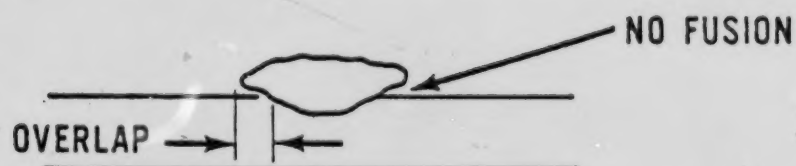
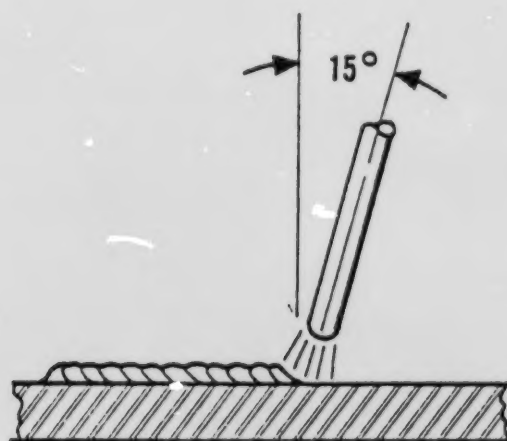
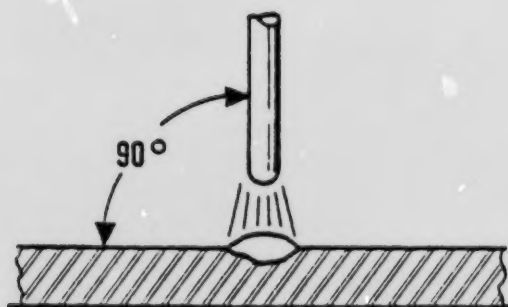
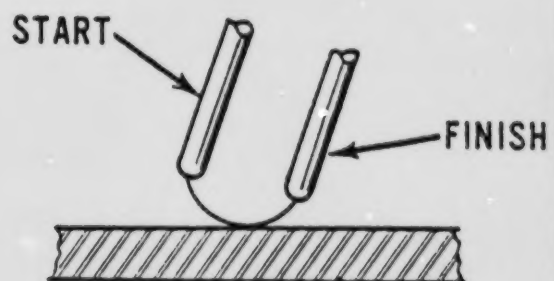
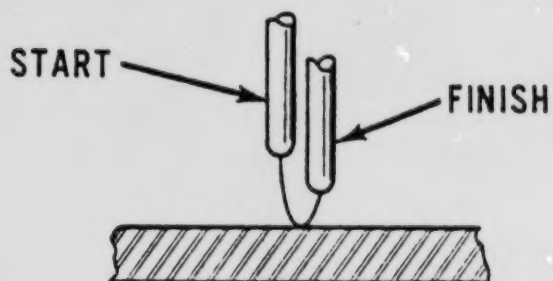
A- BARE ROD (UNSHIELDED ARC)

B COATED ROD (SHIELDED ARC)

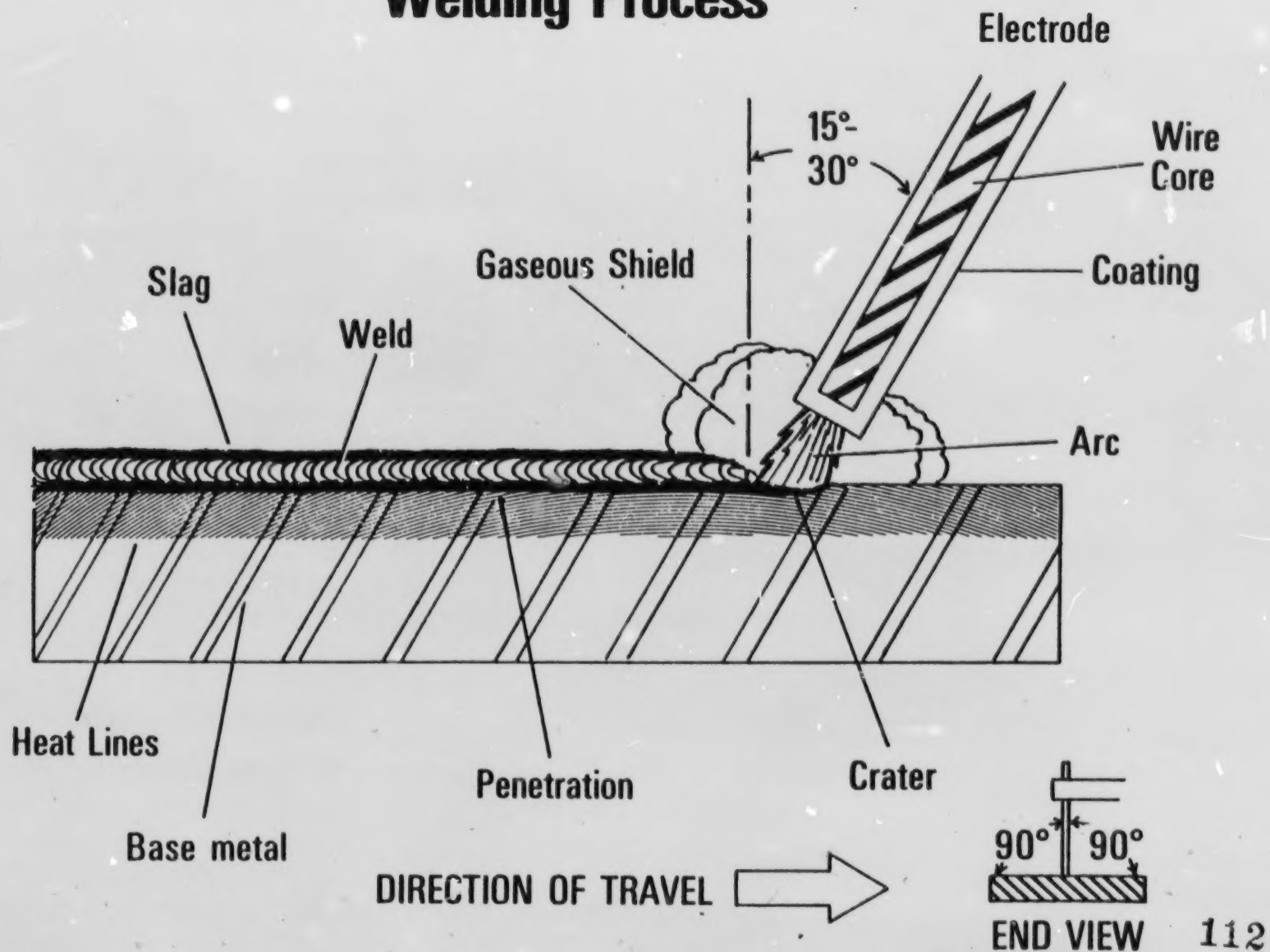
AWS Classification of Electrodes



STRIKING THE ARC AND DEPOSITING SHORT BEADS

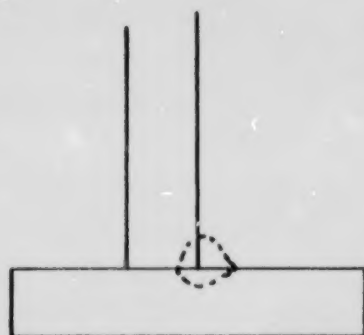


Welding Process



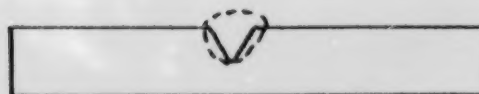
Kinds of Welds

Fillet Weld

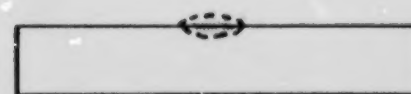


Groove Weld

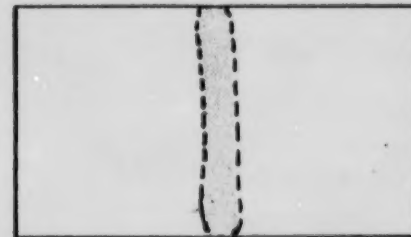
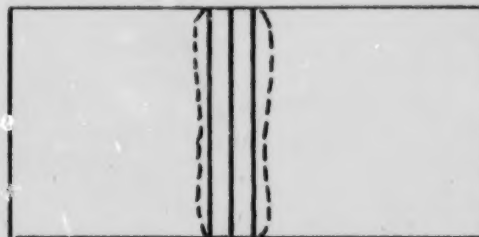
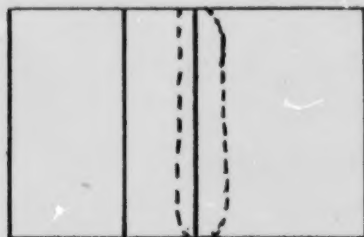
END VIEW



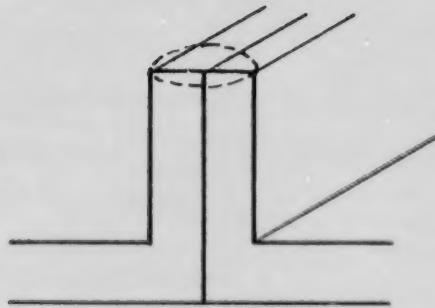
Bead Weld



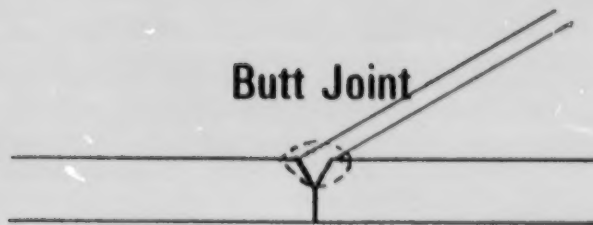
TOP VIEW



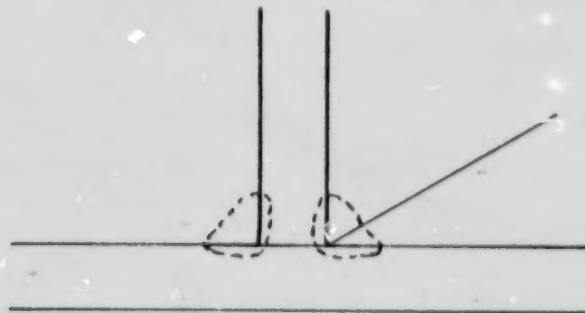
Types of Weld Joints



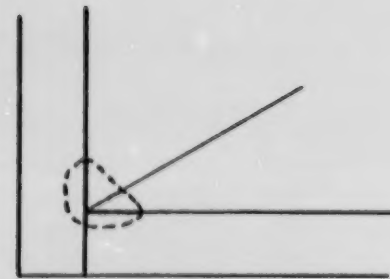
Edge Joint



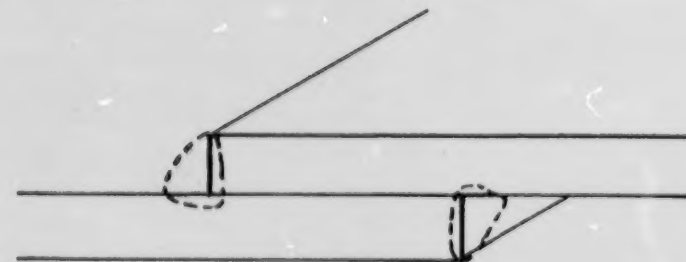
Butt Joint



T Joint

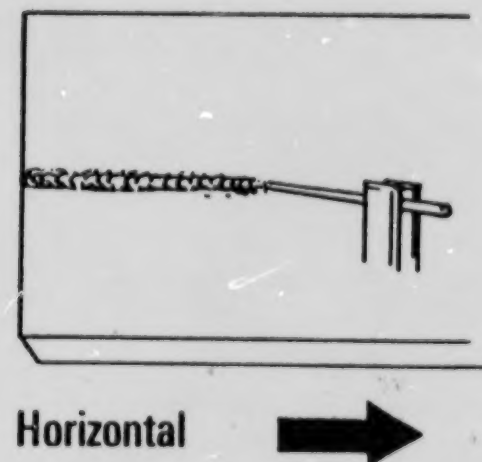
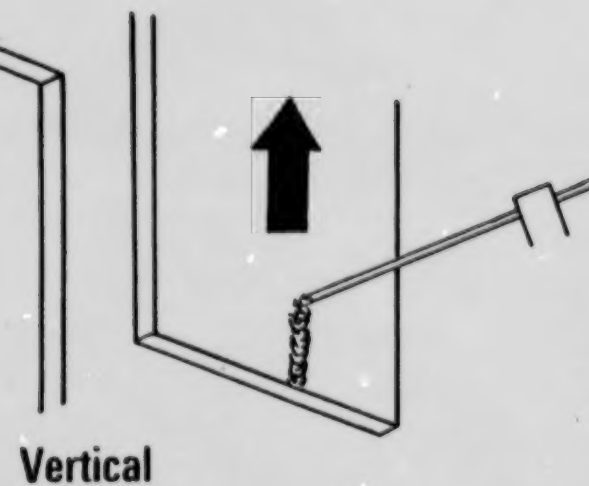
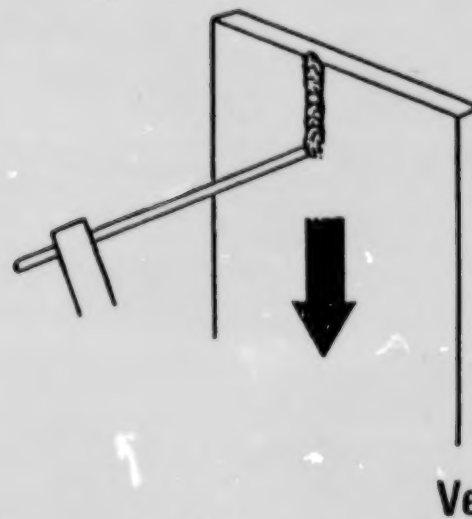
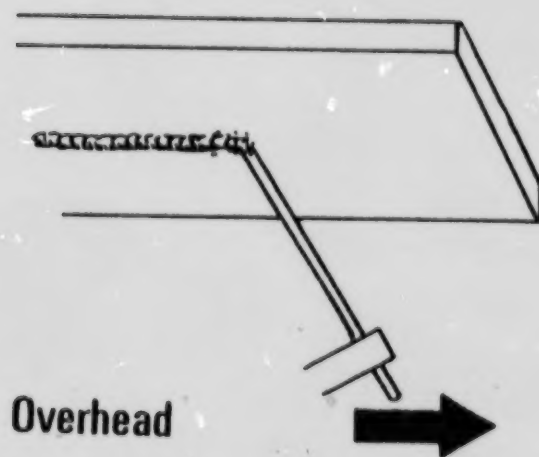
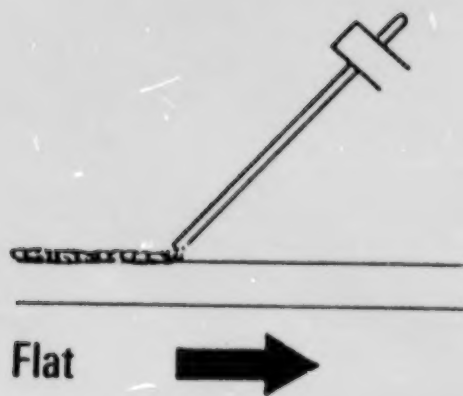


Corner Joint

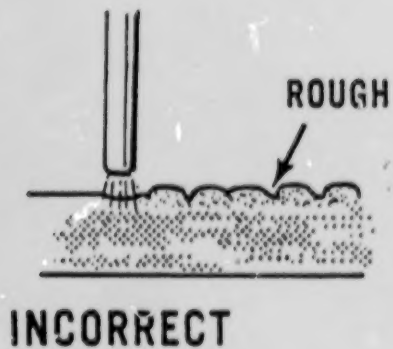
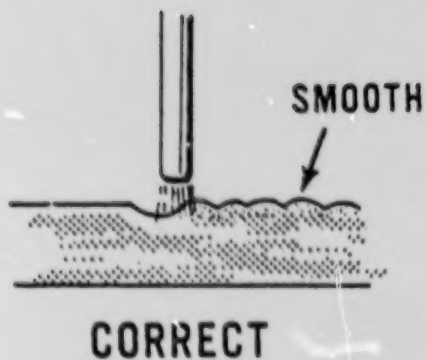


Lap Joint

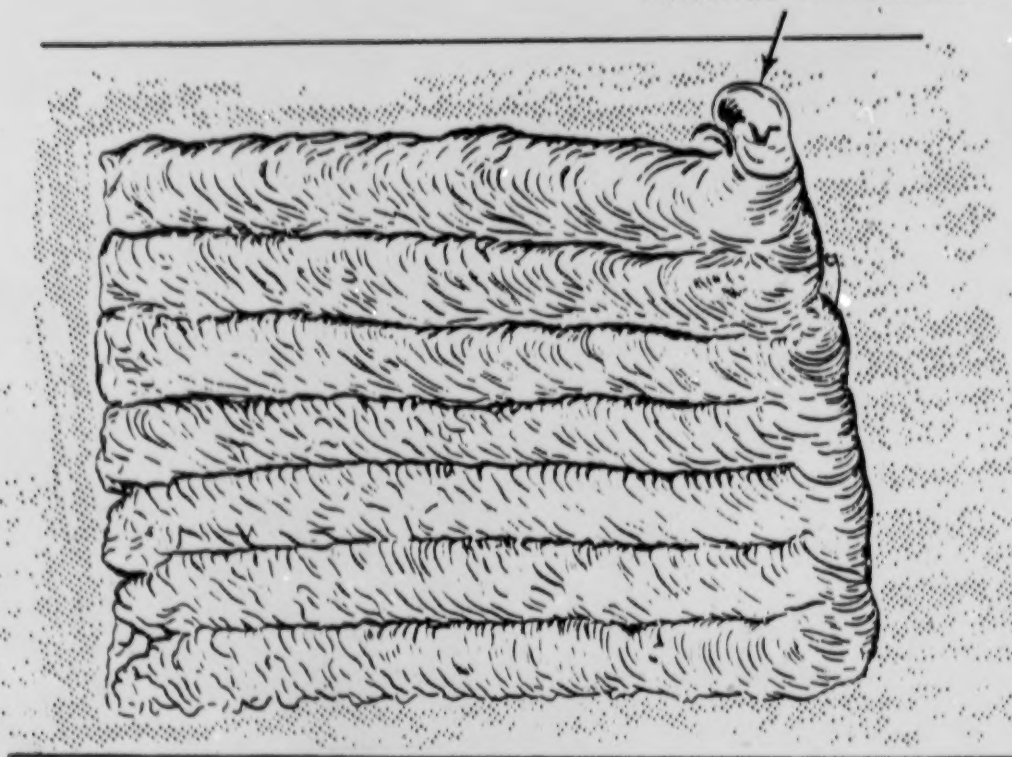
Welding Positions



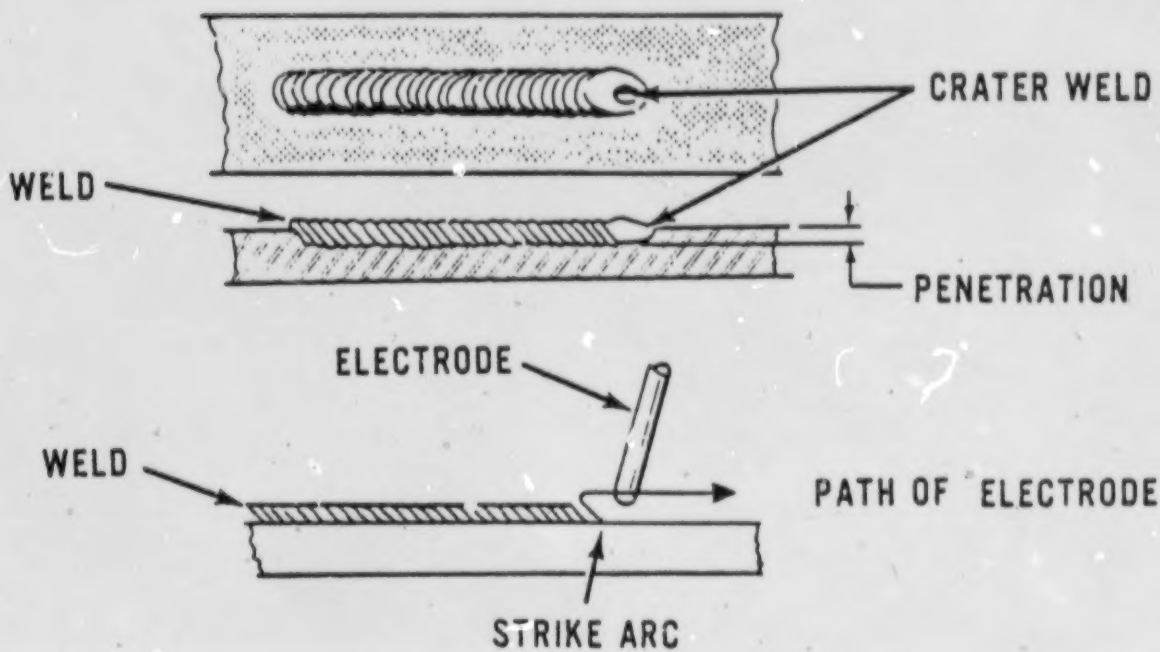
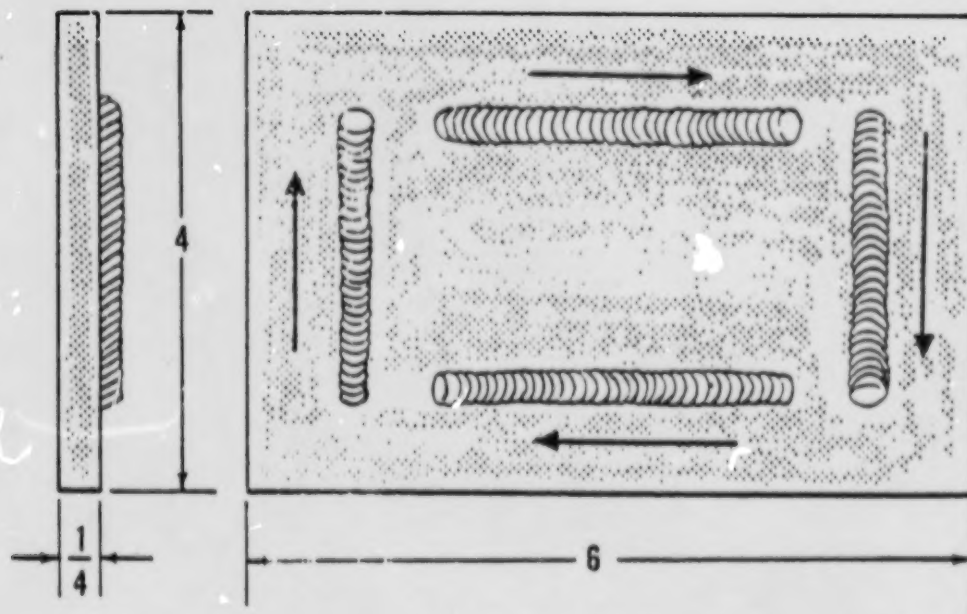
BUILD-UP OPERATION



BEADS HOOKED GIVE
FINISHED APPEARANCE



DEPOSITING CONTINUOUS BEADS

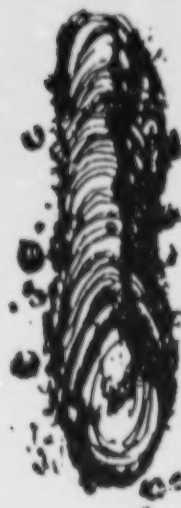


Properly and Improperly Formed Beads

Current, voltage,
and speed normal



Current high



Voltage high



Speed fast



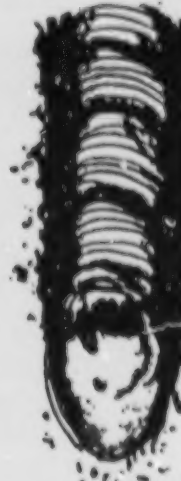
Current low



Voltage low



Speed slow



ARC WELDING
UNIT II

JOB SHEET #1 - Start, Stop, Restart a Bead

I. Equipment, materials, and tools needed

- A. Piece of metal $1/4"$ to $3/8"$ thick, $4" \times 4"$
- B. Welder
- C. Electrode holder and lead
- D. Ground clamp and lead
- E. Helmet
- F. Gloves
- G. Electrodes
- H. Safety goggles
- I. Chipping hammer
- J. Wire brush

II. Procedure

- A. Prepare metal for welding
- B. Strike arc $1"$ from edge where bead is to begin (Figures 1 and 2)

FIGURE 1

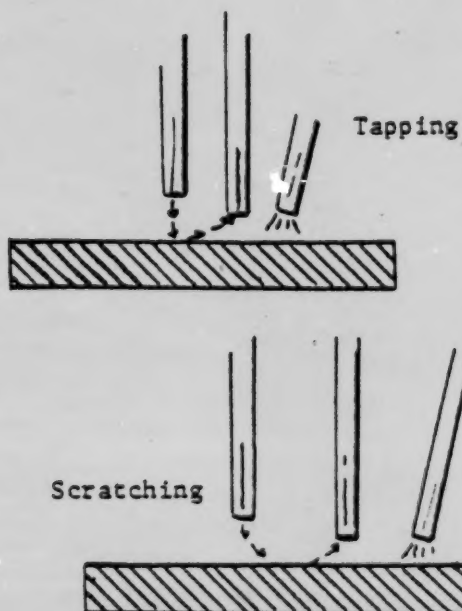
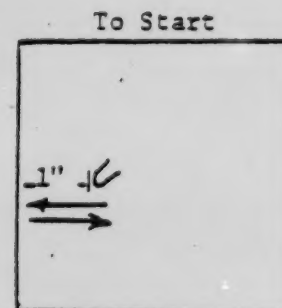
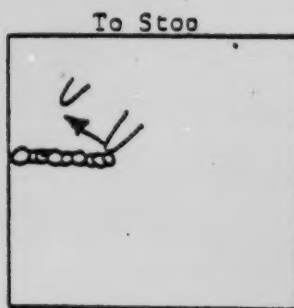


FIGURE 2



- C. When arc burns brightly, move to edge maintaining the correct arc length and begin forming the puddle
- D. Move across metal two inches
- E. To stop bead, move electrode back through the puddle and lift up (Figure 3)

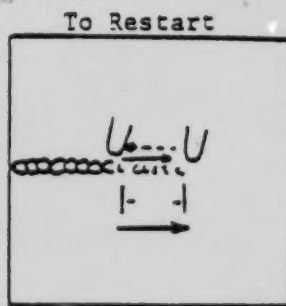
FIGURE 3



(NOTE: This will prevent cracks from forming in the puddle.)

- F. To restart, strike arc about 1" in front of crater (Figure 4)

FIGURE 4



- G. Move back through the crater when arc burns brightly and then resume the bead

(NOTE: This is necessary in order for beads to blend with one another without a change in continuity.)

ARC WELDING
UNIT II

JOB SHEET #2 - Construct a Pad

I. Equipment, tools, and materials needed

- A. Piece of metal 1/4" to 3/8" thick, 4" x 4"
- B. Welder
- C. Electrode holder and lead
- D. Ground clamp and lead
- E. Helmet
- F. Gloves
- G. Electrodes
- H. Safety goggles
- I. Chipping hammer
- J. Wire brush

II. Procedure

- A. Prepare metal for welding
- B. Strike arc and move to point to begin pad (Figure 1)

FIGURE 1



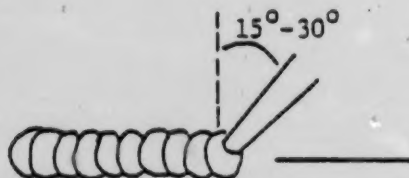
- C. Lay a straight bead across the plate using a weaving motion

(NOTE: In using #6011 electrode, it is necessary to use some type of rod manipulation in running a bead.)

- D. Hold electrode at a 15° to 30° angle in direction of travel and lower electrode as rod burns away to maintain correct arc length (Figure 2)

(NOTE: There should be 90° on each side of the electrode.)

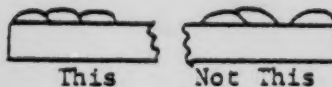
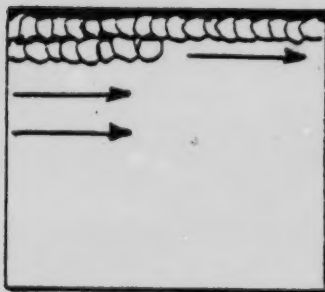
FIGURE 2



- E. Move electrode steadily from right to left across pad
F. Clean the slag from each bead before starting the next one
G. Run beads until pad is full overlapping each bead (Figure 3)

FIGURE 3

Overlap
about $\frac{1}{3}$
of bead



- H. Let each bead cool until slag is black before chipping
I. Run additional layers until desired thickness is obtained

ARC WELDING
UNIT II

JOB SHEET #3 - Construct a Butt Weld

I. Equipment, tools, and materials needed

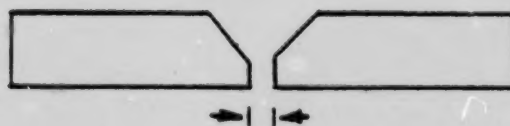
- A. Two pieces of metal, 1/4" to 3/8" thick, 3" x 6"
- B. Welder
- C. Electrode holder with leads
- D. Ground clamp with leads
- E. Helmet
- F. Gloves
- G. Electrodes
- H. Safety goggles
- I. Chipping hammer
- J. Wire brush

II. Procedure

- A. Prepare metal to be welded (Figure 1)

(NOTE: If metal thickness is over 1/8", then the edges should be beveled.)

FIGURE 1



1/16" to 3/32"

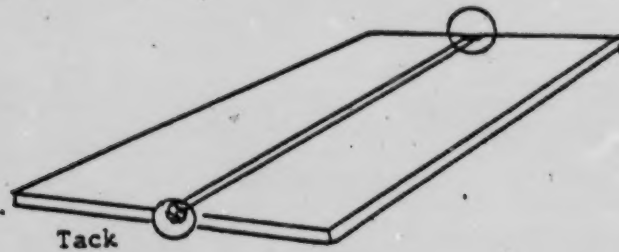
Bevel Edges

- B. Place two pieces of metal parallel to each other

(NOTE: Leave a space from 1/16" to 3/32" between them.)

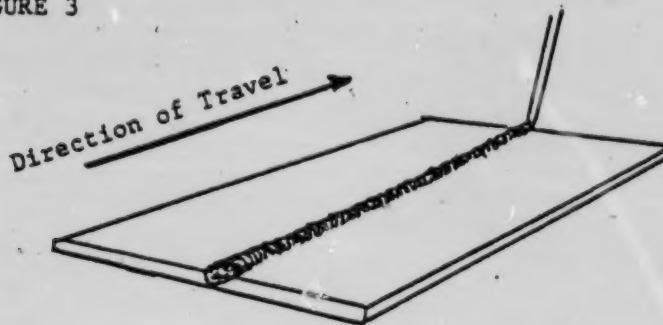
C. Tack weld pieces together at both ends (Figure 2)

FIGURE 2



D. Complete weld using a single pass (Figure 3)

FIGURE 3



E. Chip slag and brush weld

ARC WELDING
UNIT II

TEST

1. Match terms on the right to the correct definition

- | | |
|---|---------------|
| _____ a. Metal to be welded | 1. Arc |
| _____ b. Weld between two metal parts on the same plane | 2. Base metal |
| _____ c. Joining of two or more pieces of metal together by the fusion process | 3. Bead weld |
| _____ d. Flow of current across a narrow gap | 4. Bevel |
| _____ e. Made by one pass of the electrode | 5. Butt joint |
| _____ f. Type of edge preparation | 6. Crater |
| _____ g. Depression at the end of the weld | 7. Electrode |
| _____ h. Metal rod which conducts a current from the electrode holder to the base metal | 8. Welding |
| _____ i. American Welding Society | 9. A.W.S. |

2. List five safety precautions used in arc welding.

- a.
- b.
- c.
- d.
- e.

3. List two kinds of arc welders.

- a.
- b.

4. Select from the following list common equipment used in arc welding by placing an "X" in the blank.

- ☐ a. Welder
- ☐ b. Torch
- ☐ c. Table
- ☐ d. Shield or helmet
- ☐ e. Gloves
- ☐ f. Ground clamp with lead
- ☐ g. Tape
- ☐ h. Wire brush
- ☐ i. Electrode
- ☐ j. Base metal

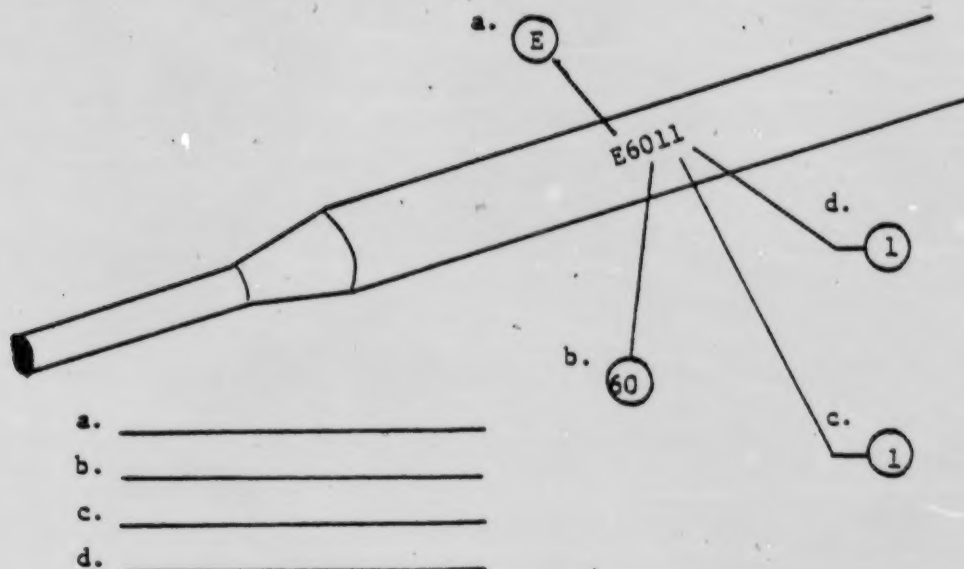
5. List four types of electrodes.

- a.
- b.
- c.
- d.

6. Place an "X" by the two most common sizes of electrodes used in an agricultural mechanics program.

- ☐ a. 1/4"
- ☐ b. 1/8"
- ☐ c. 1/16"
- ☐ d. 5/32"
- ☐ e. 3/8"
- ☐ f. 3/32"
- ☐ g. 3/16"
- ☐ h. 3/64"

7. Identify the meaning of the numbers in the electrode classification system from the drawing.

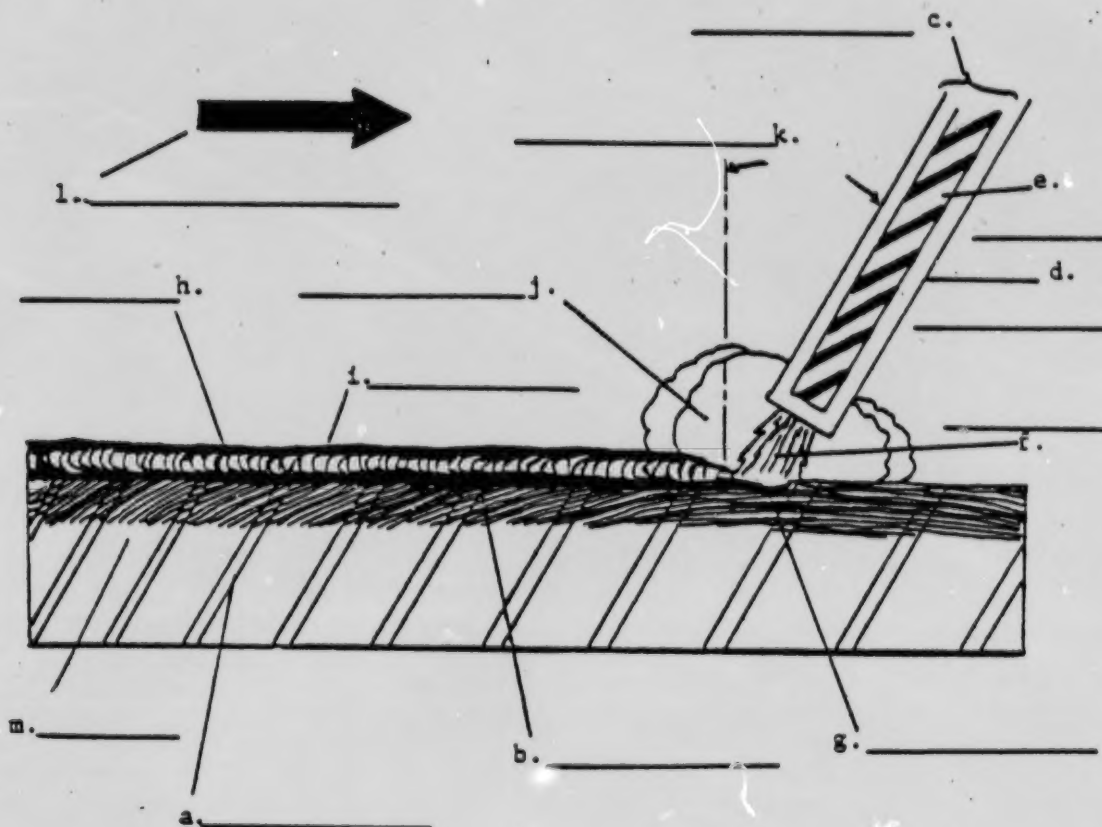


8. Name two methods of coating electrodes.
- a. _____
b. _____
9. List three purposes of electrode coating.
- a. _____
b. _____
c. _____
10. Describe the effect of raising and lowering the arc welding current.
11. Name two methods of establishing an arc.
- a. _____
b. _____

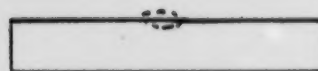
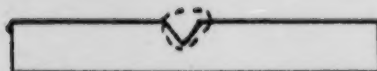
12. Select from the list below characteristics of the proper arc length by placing an "X" in the blank by the proper statements.

- ____ a. Arc length is always 1/2" long
- ____ b. Arc length is the same as the length of the electrode
- ____ c. End of electrode is the same distance from the base metal as the diameter of the electrode
- ____ d. Correct arc length makes a steady hum of the welder and a "frying" sound at the arc

13. Label the parts of the drawing associated with the welding process.



14. Identify the following welds.



a. _____

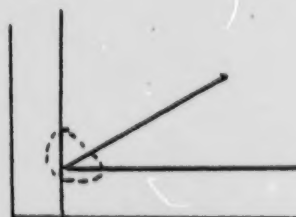
b. _____

c. _____

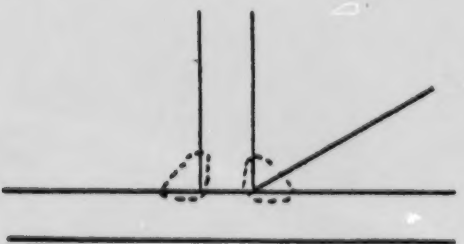
15. Identify five types of weld joints.



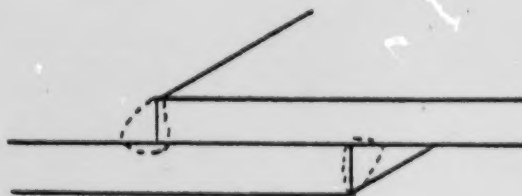
a. _____



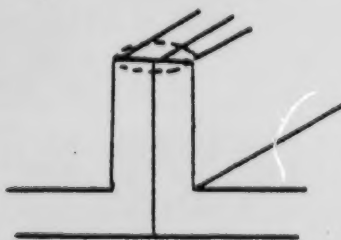
b. _____



c. _____



d. _____



e. _____

16. List four welding positions.

- a.
- b.
- c.
- d.

17. List four reasons for poor welds.

- a.
- b.
- c.
- d.

18. Name the five essentials for a proper welding procedure.

- a.
- b.
- c.
- d.
- e.

19. Demonstrate the ability to:

- a. Start, stop, and restart a bead.
- b. Construct a pad weld.
- c. Construct a butt weld.

(NOTE: If these have not been completed before the test, ask the instructor when the above activities should be completed.)

ARC WELDING
UNIT II

ANSWERS TO TEST

1.
 - a. 2
 - b. 5
 - c. 8
 - d. 1
 - e. 3
 - f. 4
 - g. 6
 - h. 7
 - i. 9
2. Any five of the following:
 - a. Never look at arc with the naked eye
 - b. Use a head or face shield that is in good condition
 - c. Wear suitable clothing to protect all parts of the body
 - d. Do not strike an arc or weld until you are sure those in the vicinity have protective equipment or will look in the other direction
 - e. Do not weld around combustible or flammable materials
 - f. Do not pick up hot metal
 - g. Do not weld in confined places without ventilation
 - h. Always open main switch or disconnect plug when checking over a welder
 - i. Do not leave electrode holder on welding table or in contact with grounded metal surface
 - j. Do not use worn or frayed cables
 - k. Stand on dry footing when welding
 - l. Keep area around welder clean
 - m. Keep tools and metals in their proper locations
3. Any two of the following:
 - a. A.C.
 - b. D.C.
 - c. TIG
 - d. MIG

4. a,d,e,f,h,i
5.
 - a. Mild steel
 - b. High carbon steel
 - c. Hard surfacing
 - d. Alloys--Special purpose
6. b,d
7.
 - a. Arc welding electrode
 - b. Tensile strength
 - c. Welding position
 - d. Special characteristics
8. Any two of the following:
 - a. Wrapping
 - b. Dipping
 - c. Extruding
9. Any three of the following:
 - a. Stabilizes arc
 - b. Shields molten puddle from air
 - c. Floats impurities out of puddle
 - d. Forms slag and slows cooling
 - e. Increases speed and improves quality of weld
10. Description should include:
 - a. Raising current--Produces more heat
 - b. Lowering current--Produces less heat
11.
 - a. Scratching
 - b. Tapping
12. c,d

- 13.
 - a. Base metal
 - b. Penetration
 - c. Electrode
 - d. Coating (flux)
 - e. Wire core
 - f. Arc
 - g. Crater
 - h. Slag
 - i. Weld
 - j. Gaseous shield
 - k. $15^{\circ} - 30^{\circ}$
 - l. Direction of travel
 - m. Heat lines

- 14.
 - a. Fillet
 - b. Groove
 - c. Bead

- 15.
 - a. Butt
 - b. Corner
 - c. T
 - d. Lap
 - e. Edge

- 16.
 - a. Flat
 - b. Vertical
 - c. Overhead
 - d. Horizontal

- 17. Any four of the following:
 - a. Machine adjustment too hot or too cool
 - b. Electrode size too large or too small
 - c. Improper movement of electrode

- d. Improper angle of holding electrode
 - e. Improper base metal preparation
 - f. Arc length too short or too long
18. a. Select the proper electrode - size and type)
b. Select the correct amperage
c. Use correct travel speed
d. Position the electrode correctly
e. Use proper joint preparation and positioning
19. Performance skills will be evaluated to the satisfaction of the instructor.

SERVICING WHEEL BEARINGS
UNIT V

TERMINAL OBJECTIVE

After the completion of Unit V, the student should be able to name the common causes of wheel bearing failures and identify the components of a wheel assembly. He should be able to disassemble, clean, and pack and assemble wheel bearings. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After the completion of this unit, the student should be able to:

1. Explain in writing the importance of wheel bearing service.
2. Select from a list the proper service interval for wheel bearings.
3. Name the common causes of wheel bearing failures.
4. Identify the components of a wheel assembly.
5. Demonstrate the ability to:
 - a. Disassemble the wheel bearings
 - b. Clean the wheel bearings
 - c. Pack and assemble the wheel bearings

SERVICING WHEEL BEARINGS
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparency.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in the job sheets.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency master
 - 1. TM 1 - Components of a Wheel Assembly
- D. Job sheets
 - 1. Job Sheet #1 - Disassemble the Wheel Bearings
 - 2. Job Sheet #2 - Clean the Wheel Bearings
 - 3. Job Sheet #3 - Pack and Assemble the Wheel Bearings
- E. Test
- F. Answers to test

II. References:

- A. American Association for Instructional Materials. Tractor Maintenance. Athens, Georgia: Foote and Davis (Division of McCall Printing Company), 1970.
- B. National 4-H Tractor Program Development Committee. 4-H Tractor Program Third Year. Chicago, Illinois: National 4-H Service Committee, 1963.

SERVICING WHEEL BEARINGS
UNIT V

INFORMATION SHEET

- I. Importance of wheel-bearing service--Due to work in dusty areas, tractor wheel bearings are often subjected to needless wear if not properly adjusted and lubricated

(NOTE: If grit and dirt particles are allowed to enter the bearings, damage begins to show on the raceway. If this continues, the bearing will soon be ruined and have to be replaced.)

II. Proper service interval for wheel bearings

- A. Interval varies from 500 to 1,200 hours
- B. Check tractor operator's manual for recommendations on a given tractor

(NOTE: The wheel-bearing service interval has been gradually lengthened as manufacturers have found better methods of protecting the bearings from dirt and water. The fact that wheel bearings are serviced infrequently makes it all the more important to do it regularly and properly.)

- C. If tractor has a grease fitting for gun lubrication, grease daily or twice per day
- D. Wheel bearings should be serviced at least once per year

III. Causes of wheel bearing failures

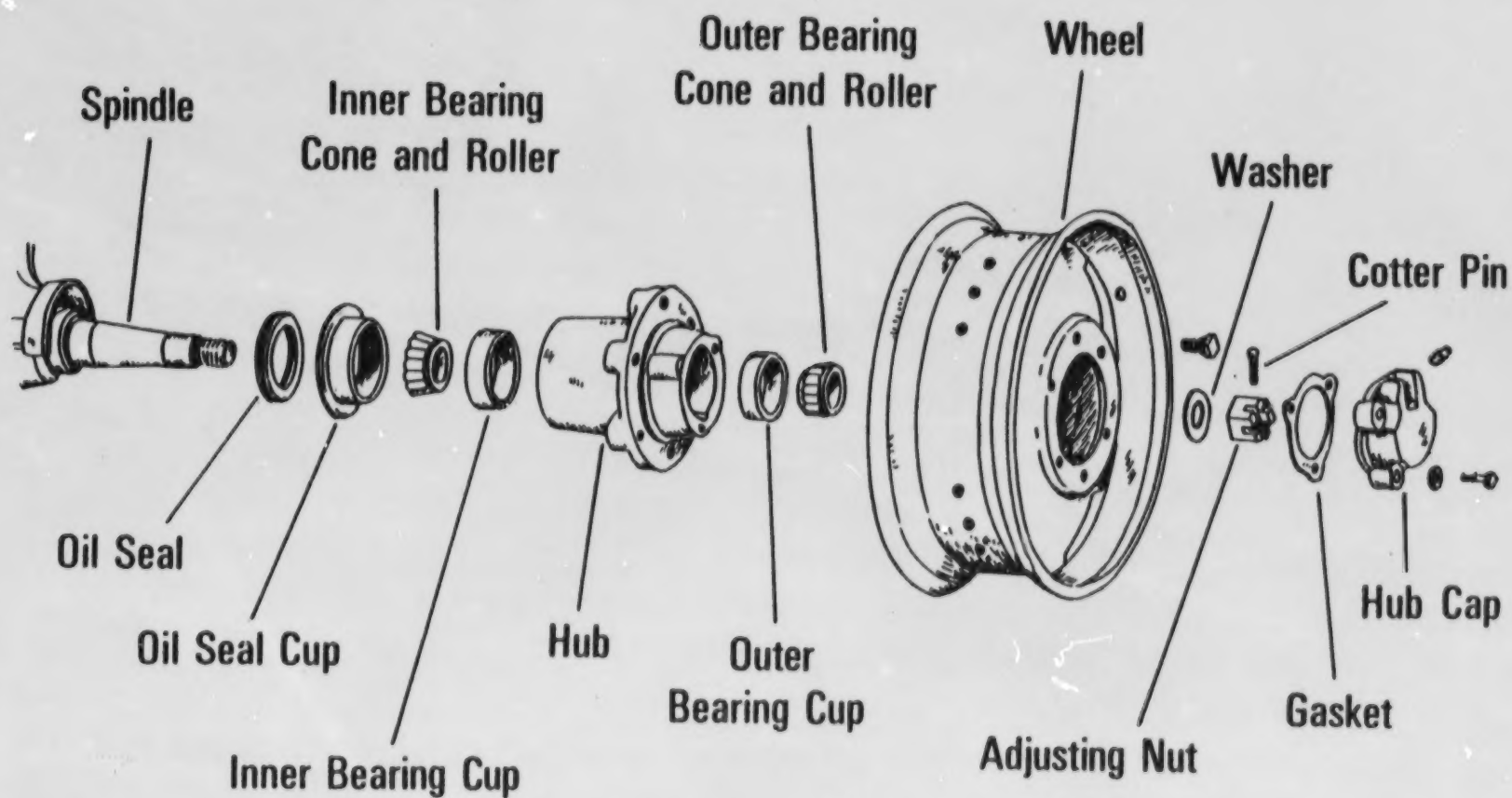
- A. Faulty dust seal
- B. Improper lubrication
- C. Loose bearings
- D. Operating wheels under water
- E. Operating the tractor with a heavy load on the wheel bearings
- F. Operating with bearings too tight

IV. Components of a wheel assembly (Transparency 1)

- A. Spindle
- B. Oil seal
- C. Oil seal cup
- D. Inner bearing cone and roller
- E. Inner bearing cup

- F. Hub
- G. Outer bearing cup
- H. Outer bearing cone and roller
- I. Wheel
- J. Washer
- K. Adjusting nut
- L. Cotter pin
- M. Gasket
- N. Hub cap

Components of a Wheel Assembly



SERVICING WHEEL BEARINGS
UNIT V

JOB SHEET #1 - Disassemble the Wheel Bearings

I. Tools and materials needed

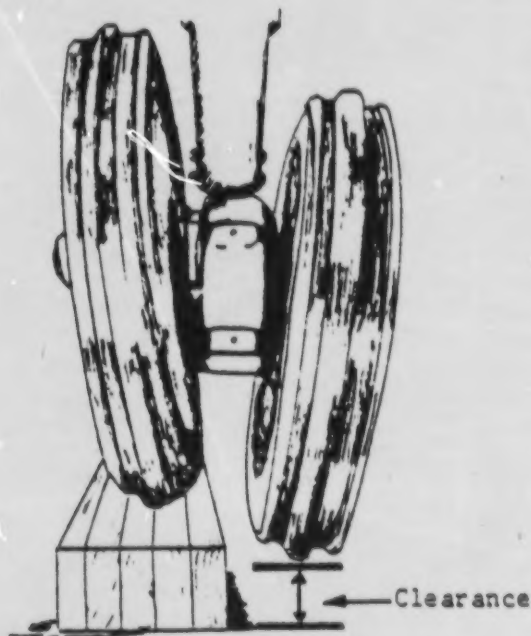
- A. Set of open-end wrenches
- B. Diagonal pliers
- C. Clean rags
- D. Wood block, about 6 inches high (for dual-wheel, tricycle tractors)
or small hydraulic jack

II. Procedure

A. Raise wheel off the ground

(NOTE: With many dual-wheel tricycle tractors, you can provide clearance for one wheel by running the other up on a six-inch block as shown in Figure 1. If your tractor has a wide front axle, jack up one wheel at a time. Be sure the tractor is in gear or block the rear wheels so it will not move forward or backward. Use caution to keep tractor from falling off jack. A stand or safety jack should be used.)

Figure 1

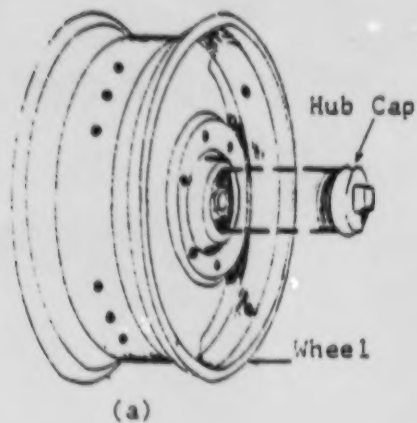


B. Clean dirt from wheel and hub cap and remove hub cap

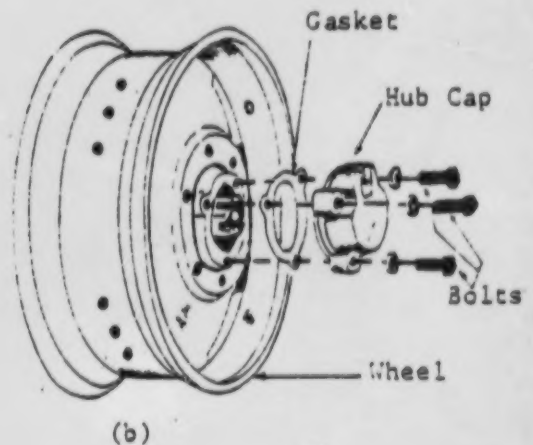
(NOTE: Most hub caps are either threaded and screwed on the hub (Figure 2a) or are held in place with three stud bolts (Figure 2b). The latter has a gasket under it. Remove the cap carefully so as not to damage the gasket.)

FIGURE 2

Threaded and Screwed On

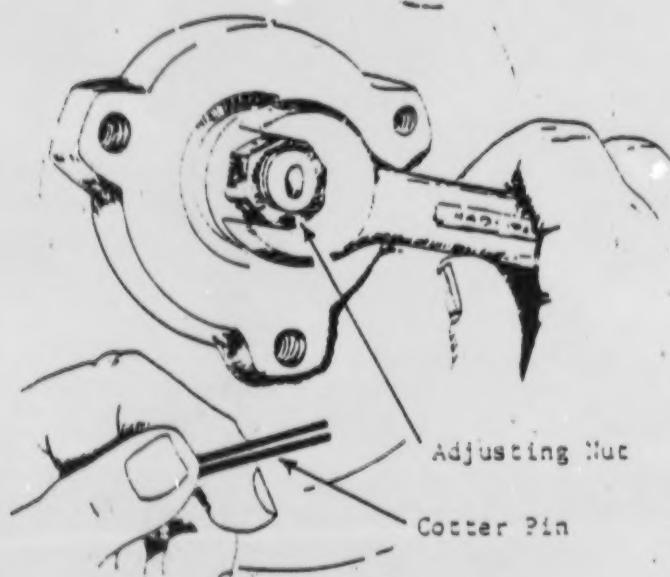


Held With Stud Bolts



C. Remove cotter pin and adjusting nut (Figure 3)

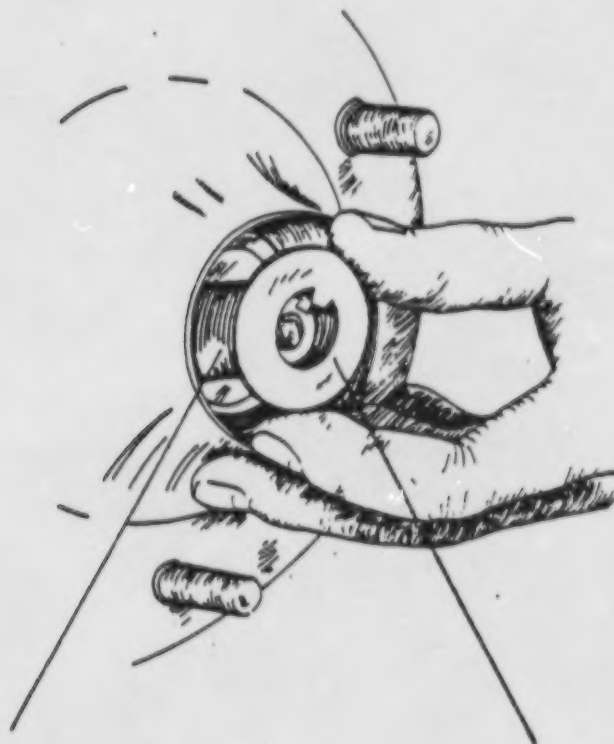
FIGURE 3



(NOTE: Use diagonal pliers for straightening cotter pin and for removing it. Lay all parts on a clean cloth or in a clean pan. It is very important to keep all of the bearing parts free from dirt. Once dirt enters the moving parts of a bearing, it is not easily removed, even in the cleaning solution. Do not use the hub cap as a container unless you can clean it first, and do not put the bearing parts on the floor.)

D. Remove thrust washer and outer bearing (Figure 4)

FIGURE 4



Outer Bearing Cone and Roller

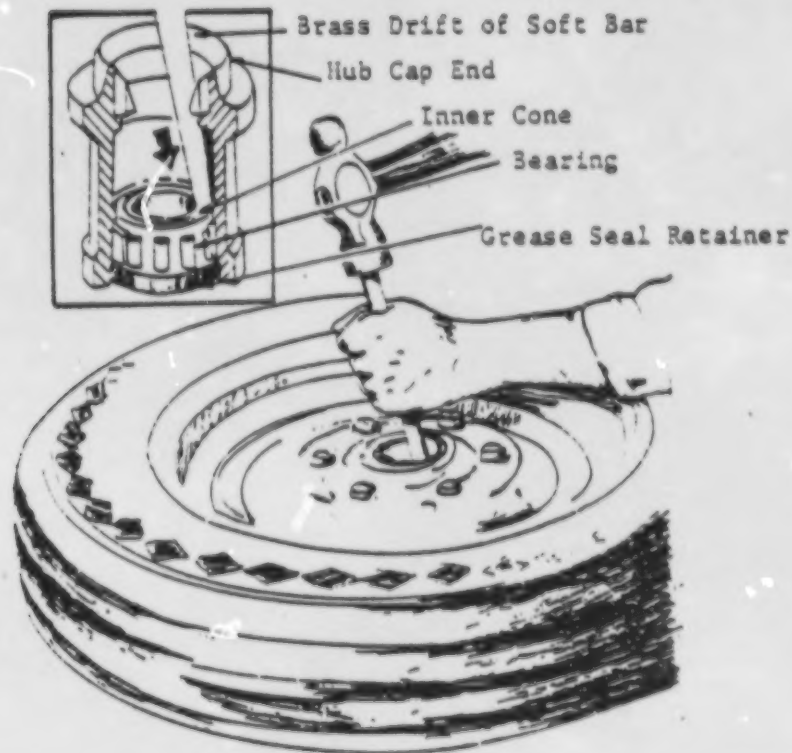
Thrust Washer

(NOTE: If the washer and outer bearing are not loose, shake the wheel gently to dislodge them. Hold your hand under the hub to keep the parts from falling on the floor.)

E. Pull wheel off the spindle

(NOTE: On some tractors the grease-seal retainer is pressed into the hub and holds the rollers and inner cone in position. With this type the bearing and seal will come off with the wheel and remain in the hub until tapped out. (Figure 5) On other tractors the grease-seal retainer remains on the spindle when the wheel is removed, which leaves the inner-bearing cone free to either come off with the wheel or remain on the spindle. If you are not certain which type of grease retainer seal is used on your tractor, hold your hand so you can catch the inner bearing as you remove the wheel, in case it should be of the latter type.)

FIGURE 5



SERVICING WHEEL BEARINGS
UNIT V

JOB SHEET #2 - Clean the Wheel Bearings

I. Tools and materials needed

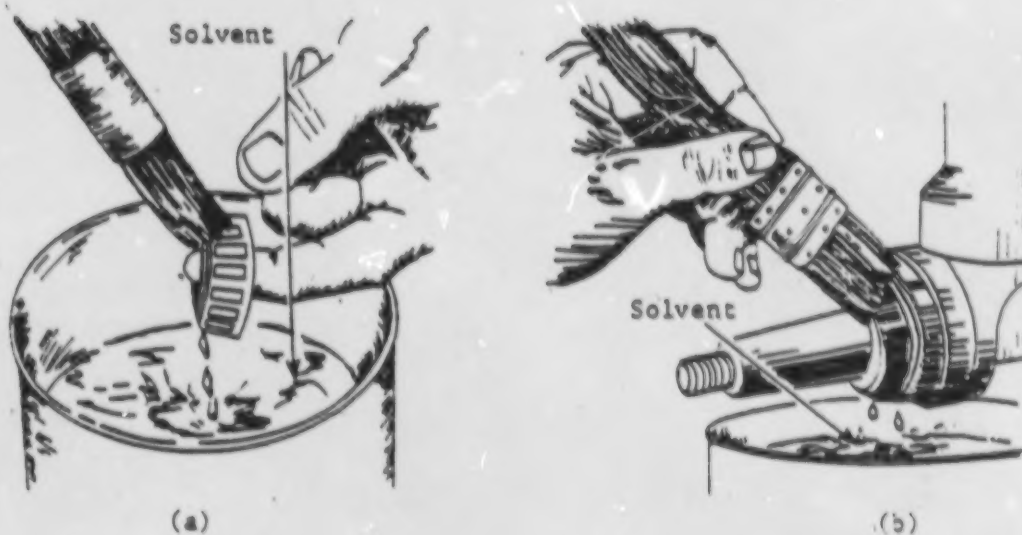
- A. Clean rags
- B. Container with cleaning solvent
- C. Small (2") brush
- D. Compressed air (if available)

II. Procedure

A. Wash bearings thoroughly

(NOTE: "Swish" the bearing in the cleaning solution (kerosene or diesel fuel) and use a stiff-bristle brush to help loosen old grease deposits. (Figure 1a) If the inner bearing is on the spindle and can not be removed easily, clean grease seal and bearing in place.) (Figure 1b)

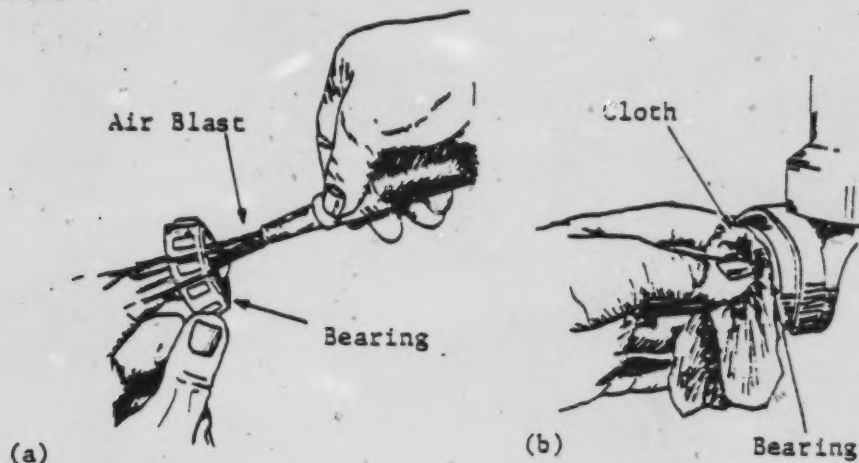
FIGURE 1



B. Remove solvent from bearings and other washed parts

(NOTE: If dry compressed air is available, it may be used for drying the bearings but hold the bearing cone so the air blast will not spin it (Figure 2a). Spinning a dry bearing causes rapid wear and it may ruin both the rollers and raceways. If the air contains moisture, do not use it. Moisture blown into the bearings will cause them to rust. Drying with a clean, dry cloth is satisfactory (Figure 2b) but be sure the cloth is free of dirt, dust, and lint.)

FIGURE 2



C. Examine bearings for wear

(NOTE: If there is evidence of much wear or corrosion, replace both parts of bearing. If inner bearing is tight on the spindle and you wish to remove it, loosen with a wood dowel and hammer. Tap lightly.)

D. Examine grease-retainer ring and seal - Replace if damaged

(NOTE: If it has been damaged (ruptured, distorted, or cracked) it should be replaced particularly for wheels with bearings that are packed only once every 500 hours or once a year. It is this seal that keeps the grease in and keeps out dirt and moisture. Much damage can be done during the interval between wheel packings if the seal leaks. Some manufacturers recommend that the seal be replaced each time a wheel bearing is repacked.)

E. Clean hub, hub cap, and spindle with solvent

SERVICING THE WHEEL BEARINGS
UNIT V

JOB SHEET #3 - Pack and Assemble the Wheel Bearings

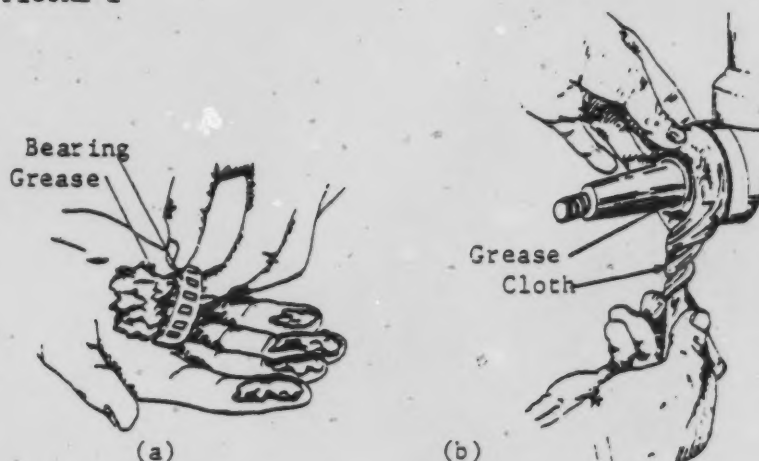
I. Tools and materials

- A. Set of open-end wrenches
- B. Diagonal pliers
- C. Clean rags
- D. Multi-purpose grease
- E. New cotter pins

II. Procedure

- A. Pack each bearing with grease (Figure 1)

FIGURE 1



(NOTE: Methods of packing bearings; (a) Place grease in hand, then push grease into bearing by pressing bearing against your palm and rotating it. Work grease entirely through bearing and between rollers. (b) If inner bearing is left on spindle, apply about two tablespoons of grease to outer portions, wrap a clean cloth around bearing, twist ends of cloth until it binds tightly around bearing. Use hand to press grease into bearing.)

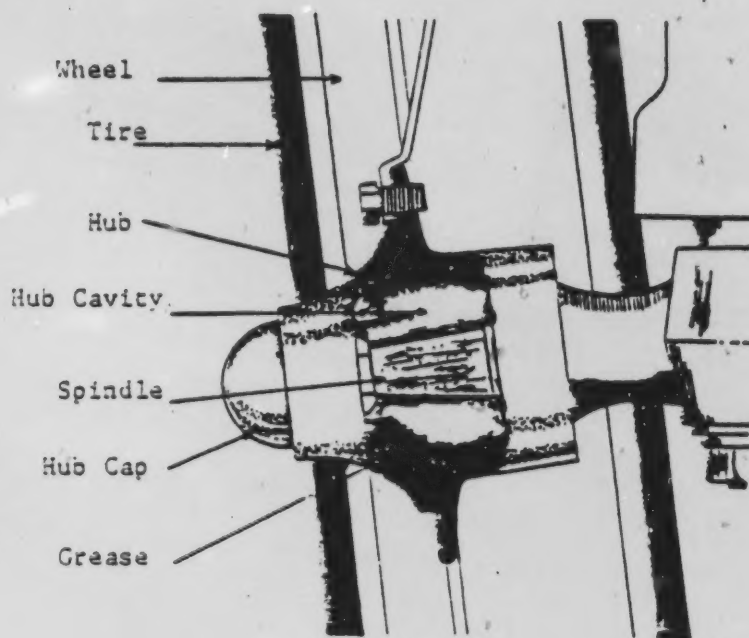
- B. Replace inner bearing and grease-retainer seal if removed originally

(NOTE: Replace in opposite sequence from that of removal whether being replaced on the spindle or in the hub. You may have to tap the grease-retainer seal lightly and evenly around the edges to set it.)

C. Coat spindle and inside of hub with grease

(NOTE: Most manufacturers recommend only a thin coating of grease--just enough to prevent rust and to help prevent entrance of dirt and water. This leaves ample air space in the hub for the grease to expand without building up pressure which will force the grease past the seal. However, there are a few companies that insist the groove, or cavity in the hub between the two roller bearings, should be filled with grease. (Figure 2) Even this practice provides considerable air space around the spindle. Check your operator's manual.)

FIGURE 2



D. Position wheel on spindle and install outer bearing

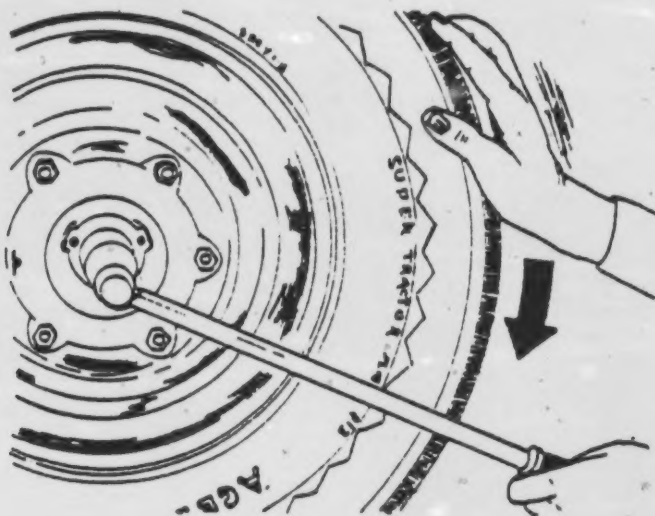
(NOTE: Be extremely careful that dirt doesn't fall from the tire or wheel on the spindle or bearing.)

E. Install thrust washer and slotted adjusting nut.

- F. Turn wheel and tighten slotted adjusting nut until wheel "drags" then loosen

(NOTE: The slotted adjusting nut is also called a "castellated" nut. Use caution while tightening (Figure 3) to avoid overtightening. Turn the wheel slowly as you tighten the nut until a slight bind is felt. The slight bind means that all surfaces are in contact. Then loosen the nut until the nearest slot (castellation) is aligned with the hole in the spindle. Some manufacturers recommend loosening the nut as much as $1/6$ to $1/3$ turn.)

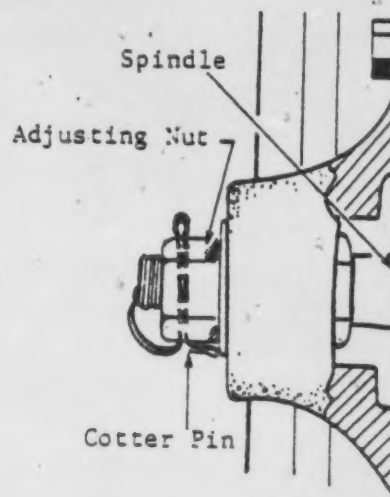
FIGURE 3



- G. Lock nut with cotter pin

(NOTE: Use a new cotter pin. Insert pin, then use diagonal pliers and pull one leg of pin outward and up over the end of the spindle. (Figure 4). Cut excess off the other cotter pin leg and bend leg backwards against nut. This assures the pin staying in place. Do not overlook this step. If the pin is not installed, the nut will gradually loosen and the wheel will come off.)

FIGURE 4



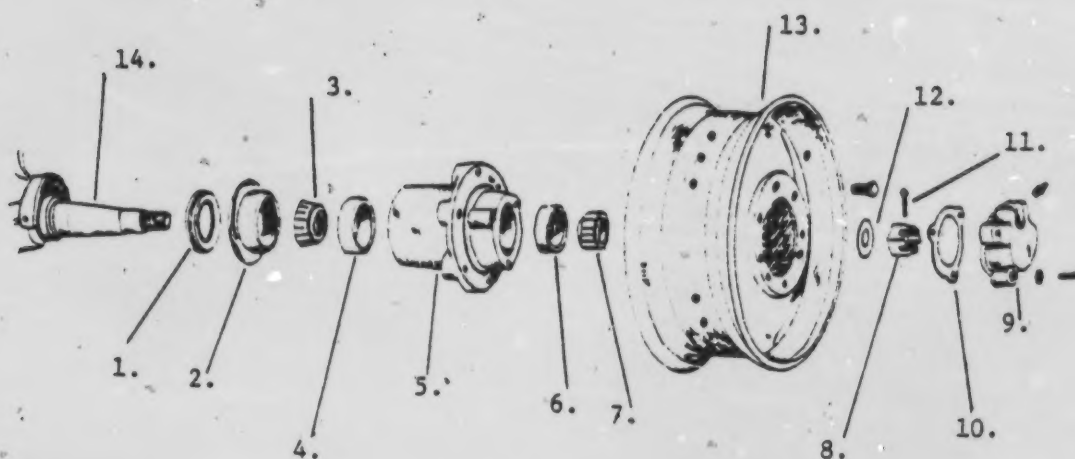
- H. Replace hub cap

SERVICING WHEEL BEARINGS
UNIT V

TEST

1. Explain in writing the importance of wheel bearing service.
2. Select from the list below the proper service interval for wheel bearings. Place an "X" by the correct answers.
 - ☐ a. Interval varies from 500 to 1,200 hours
 - ☐ b. In the winter the bearings should be serviced more often
 - ☐ c. If tractor has a grease fitting for gun lubrication, grease daily or twice per day
3. Name three causes of wheel bearing failures.
 - a.
 - b.
 - c.
4. Identify the components of a wheel assembly by matching the terms below with the numbers found on the enclosed drawing.
 - ☐ a. Wheel
 - ☐ b. Cotter pin
 - ☐ c. Outer bearing cone and roller
 - ☐ d. Hub
 - ☐ e. Oil seal
 - ☐ f. Spindle
 - ☐ g. Oil seal cap
 - ☐ h. Inner bearing cone and roller
 - ☐ i. Inner bearing cup
 - ☐ j. Washer

- ___ k. Adjusting nut
- ___ l. Hub cap
- ___ m. Gasket
- ___ n. Outer bearing cup



5. Demonstrate the ability to:

- a. Disassemble the wheel bearings.
- b. Clean the wheel bearings
- c. Pack and assemble the wheel bearings

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SERVICING WHEEL BEARINGS
UNIT V

ANSWERS TO TEST

1. Due to work in dusty areas, tractor wheel bearings are often subjected to needless wear if not kept properly adjusted or lubricated.
2. a
c
3. Any three of the following:
 - a. Faulty dust seal
 - b. Improper lubrication
 - c. Loose bearings
 - d. Operating wheels under water
 - e. Operating the tractor with a heavy load on the wheel bearings
 - f. Operating with bearings too tight
4. a. 13
b. 11
c. 7
d. 5
e. 1
f. 14
g. 2
h. 3
i. 4
j. 12
k. 8
l. 9
m. 10
n. 6
5. Performance skills will be evaluated to the satisfacton of the instructor.

INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to list the characteristics of the gases used and identify parts of the oxyacetylene cutting equipment. He should also be able to turn on, light, adjust to a neutral flame, and turn off the oxyacetylene equipment following the correct procedure and observing safety precautions. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with oxyacetylene cutting.
2. List five safety precautions to observe when handling oxyacetylene equipment.
3. Write the characteristics of gases used in oxyacetylene cutting.
4. List the three components of a fire triangle.
5. Identify parts of oxyacetylene cutting equipment.
6. Identify three types of flame.
7. Demonstrate the ability to:
 - a. Set up the oxyacetylene cutting equipment.
 - b. Turn on, light, adjust to a neutral flame, and turn off the oxyacetylene equipment.

INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

SUGGESTED ACTIVITIES

- I. Instructor:
 - A. Provide students with objective sheet
 - B. Provide students with information and job sheets
 - C. Make transparencies
 - D. Discuss terminal and specific objectives
 - E. Discuss information sheet
 - F. Demonstrate and discuss procedures outlined in job sheets
 - G. Give test
- II. Student:
 - A. Read objectives
 - B. Study information sheet and take notes
 - C. Complete the procedures outlined in the job sheets
 - D. Take test

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objectives
 - B. Information sheet
 - C. Transparency masters
 - 1. TM 1 - The Fire Triangle
 - 2. TM 2 - Oxyacetylene Cutting Equipment
 - 3. TM 3 - Welding Regulators
 - 4. TM 4 - Oxyacetylene Cutting Flames
 - D. Job sheets
 - 1. Job Sheet #1 - Set up Oxyacetylene Equipment
 - 2. Job Sheet #2 - Turn on, Light, Adjust the Cutting Torch to a Neutral Flame, and Turn Off the Oxyacetylene Cutting Equipment
 - E. Test
 - F. Answers to test

II. References:

- A. Smith's Instructor's Manual for a Basic Course in Oxyacetylene Brazing, (form 424). Minneapolis, Minnesota: Smith Welding Equipment, Division of Tescom Corporation.
- B. Phipps, Lloyd J. Mechanics in Agriculture. Danville, Illinois: Interstate Printers and Publishers, Inc., 1967
- C. Oxyacetylene Flame Tracts (form 235). Minneapolis, Minnesota: Smith Welding Equipment, Division 7 Tescom Corporation.
- D. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. Modern Welding. Homewood, Illinois: Goodheart-Villcox Co., Inc., 1970.

INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

INFORMATION SHEET

I. Terms and definitions

- A. Oxyacetylene cutting - The severing of ferrous metals by heating and rapid oxidation of metal with pure oxygen
- B. Oxidation - Combining oxygen with another substance
- C. Oxide - Term usually applied to rust, corrosion, coating, film, or scale
(NOTE: Oxygen combines with metal causing oxides.)
- D. Backfire - A short "pop" of the torch flame followed by extinguishing of the flame or continued burning of the gases
- E. Flashback - Fire burning inside the torch
- F. Purge - Clear or make free of foreign material or impurities

II. Safety precautions for handling oxyacetylene equipment

(NOTE: The Mathematics of Safety - Accidents SUBTRACT from your pleasure, ADD to your miseries, DIVIDE your income, and MULTIPLY your worries.)

- A. Blow out cylinder valve (crack valve for a second) before attaching regulators
- B. Release adjusting screw on regulator before opening cylinder valve
- C. Stand to side of regulator when opening cylinder valve
- D. Open cylinder valves slowly
- E. Do not use acetylene (in free state) at pressures higher than 15 PSI
- F. Purge Oxygen and fuel gas passages (individually) before lighting torch
- G. Light fuel gas before opening oxygen valve on torch
- H. Use no oil on regulator, torches, fittings, etc.
- I. Do not use oxygen as a substitute for compressed air
- J. Keep heat, flames, and sparks away from combustibles

III. Characteristics of gases

A. Acetylene

- 1. Colorless
- 2. Has distinct odor
- 3. Combustible

(NOTE: When combined with oxygen, acetylene produces a flame of about 5900°-6300° F.)

B. Oxygen

1. Colorless
2. Oderless
3. Tasteless
4. Supports and intensifies comustion

IV. Componests of a fire triangle (Transparency 1)

- A. Fuel - Any combustible material
- B. Heat - Enough to raise the fuel to its ignition temperature
- C. Oxygen - Necessary to sustain combustion

(NOTE: To produce fire, these three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.)

V. Parts of oxyacetylene equipment (Transparencies 2 and 3)

- A. Oxygen cylinder
- B. Oxygen cylinder valve
- C. Acetylene cylinder
- D. Acetylene cylinder valve
- E. Acetylene regulator
- F. Oxygen regulator
- G. Cylinder truck
- H. Safety chain
- I. Acetylene fitting

(NOTE: Acetylene fitting has left-handed threads and a hex-grooved nut.)

J. Oxygen fitting

(NOTE: Oxygen fitting has right-handed threads.)

- K. Acetylene torch valve
- L. Oxygen torch valve
- M. Torch body
- N. Cutting attachment
- O. Oxygen cutting lever
- P. Oxygen preheat valve
- Q. Tip nut
- R. Slip-in tip

VI. Types of flames (Transparency 4)

A. Carburizing - Burns an excess of acetylene

.. (NOTE: A carburizing flame may be identified by the feathery edges of the white cone.)

B. Oxidizing - Burns excess of oxygen

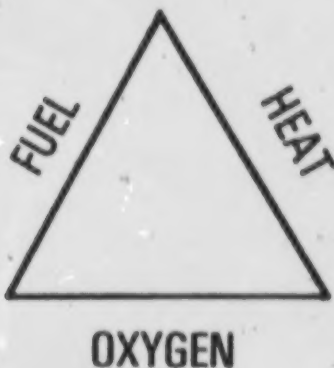
(NOTE: An oxidizing flame may be identified by the short white inner cone.)

C. Neutral - Burns equal amounts of oxygen and acetylene

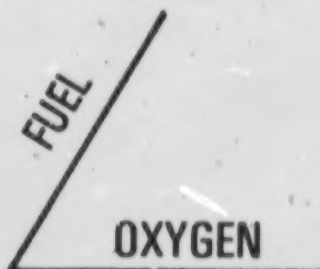
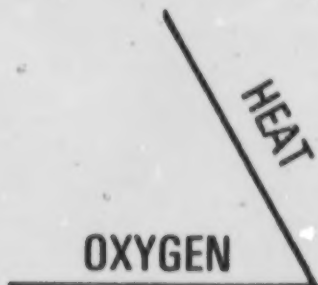
(NOTE: A neutral flame may be identified by a clear, well defined white cone.)

The Fire Triangle

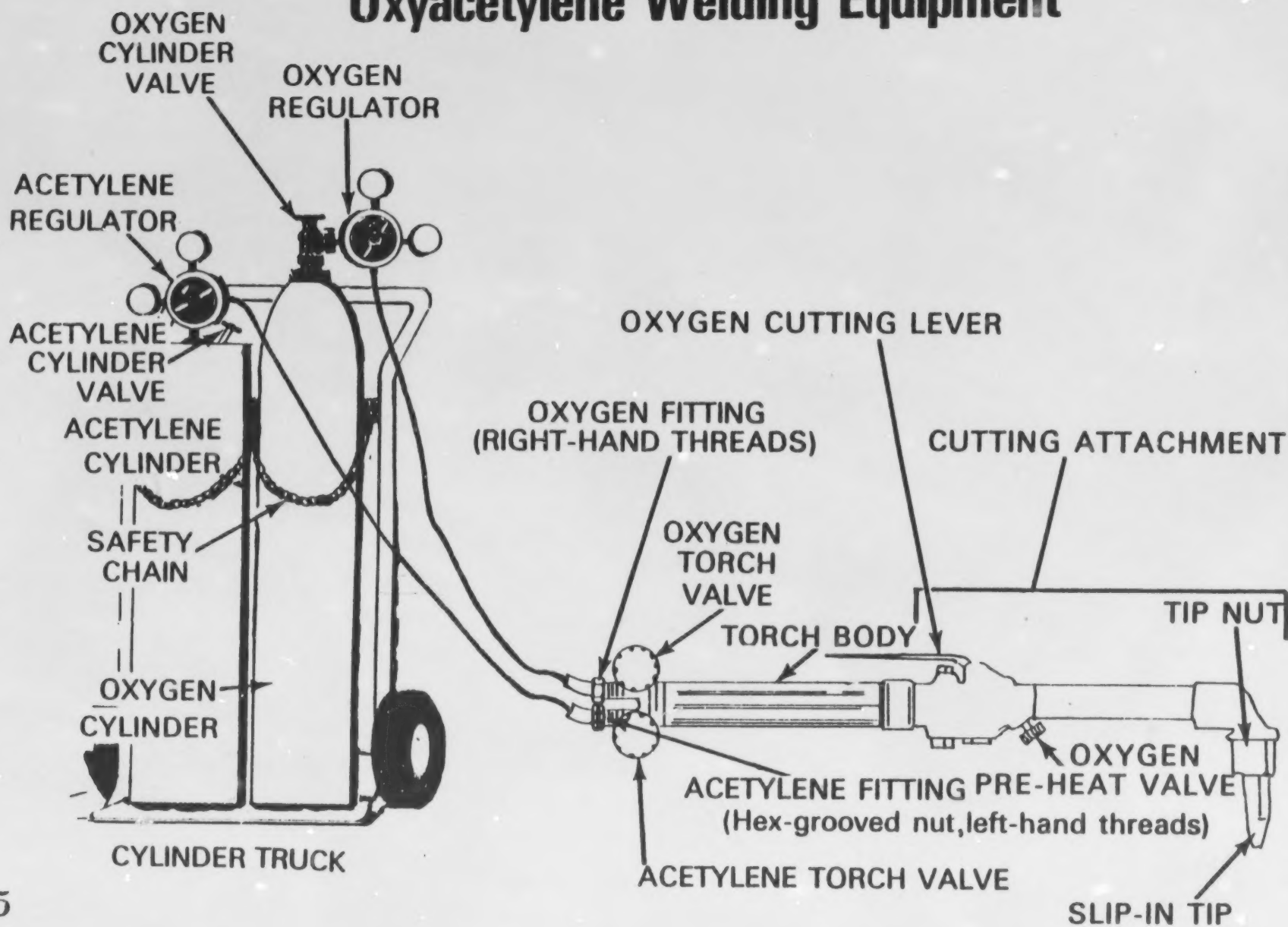
To produce fire, three things must be present at the same time.



If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.

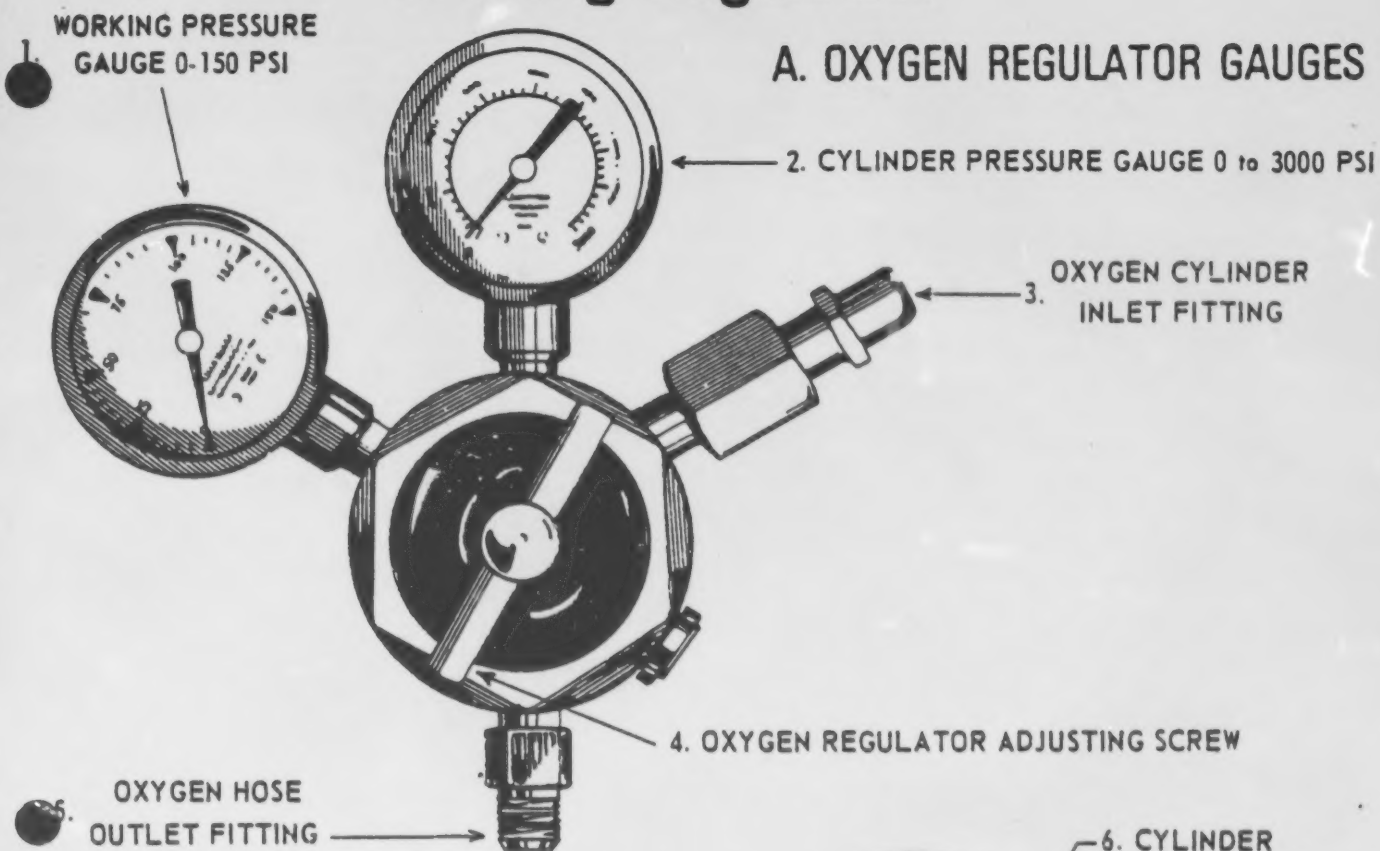


Oxyacetylene Welding Equipment

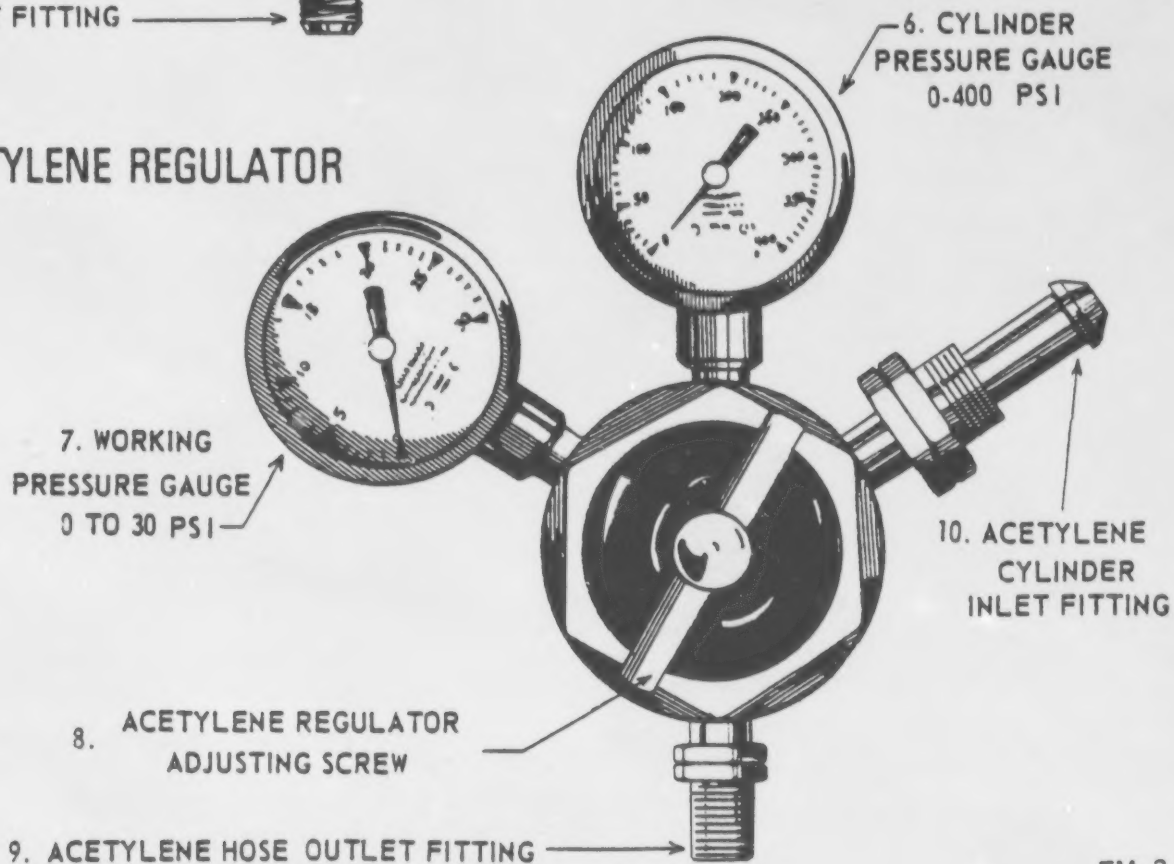


Welding Regulators

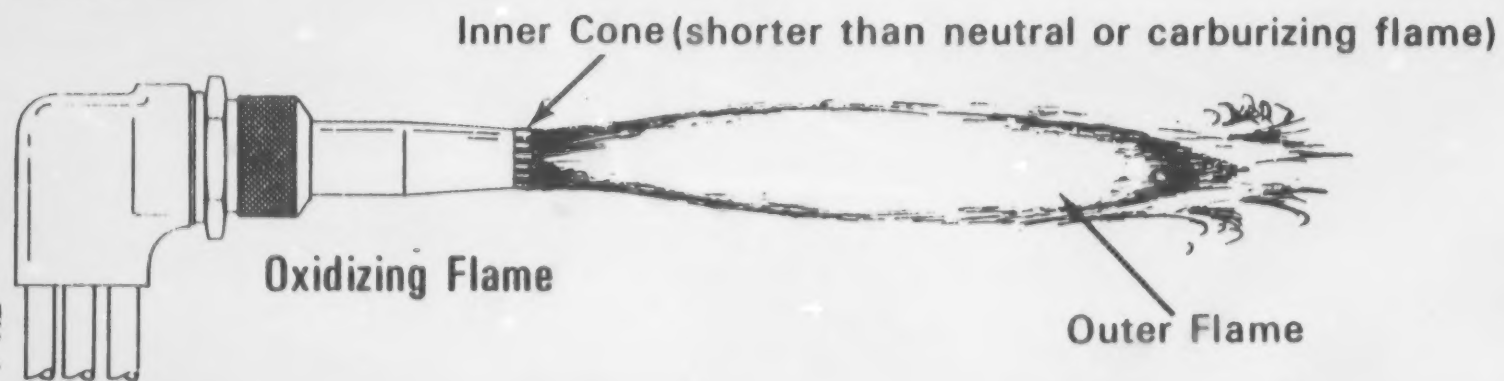
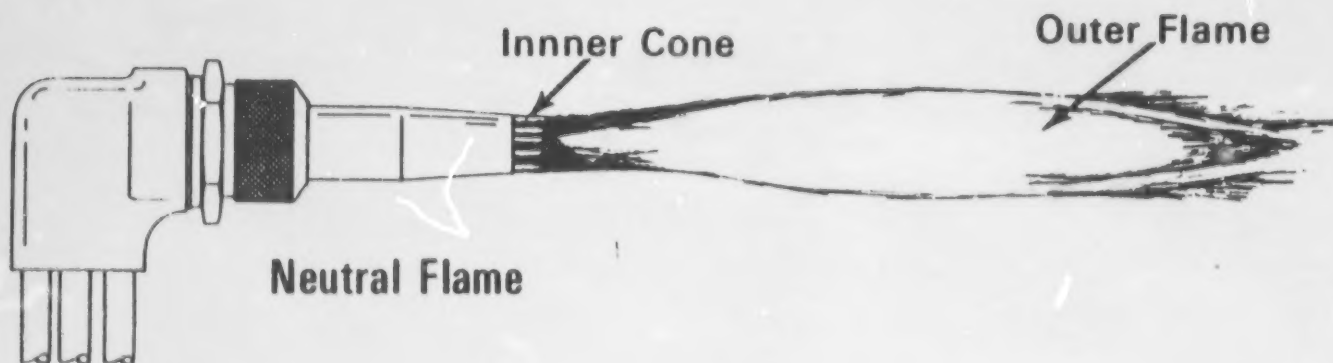
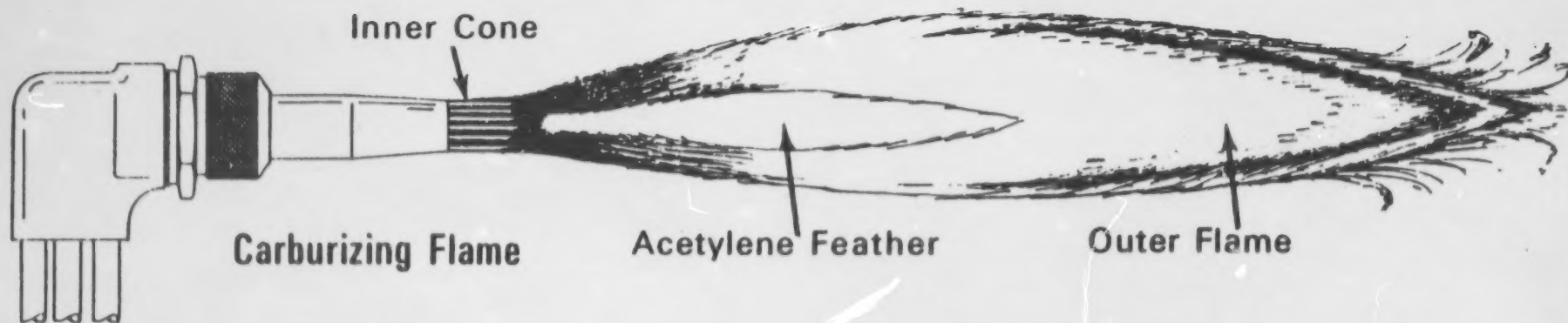
A. OXYGEN REGULATOR GAUGES



B. ACETYLENE REGULATOR



Oxyacetylene Cutting Flames



INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

JOB SHEET #1 - Set up Oxyacetylene Equipment

I. Tools and materials needed

- A. Oxygen cylinder
- B. Acetylene cylinder
- C. Oxygen regulator
- D. Acetylene regulator
- E. Hoses
- F. Wrench
- G. Cylinder holder
- H. Water container
- I. Ivory soap
- J. Clean paint brush
- K. Torch body with cutting attachment

II. Procedure

- A. Fasten cylinders in a vertical position
- B. Remove caps from cylinders
- C. Crack valves of each cylinder, then close valves
- D. Connect oxygen regulator to oxygen cylinder
 - 1. Turn adjusting screw on regulator counterclockwise until tension on spring is released
 - 2. Slowly turn cylinder valve wide open
- E. Connect acetylene regulator to acetylene cylinder
 - 1. Turn adjusting screw on regulator counterclockwise until tension on spring is released
 - 2. Open cylinder valve $1/2$ to $3/4$ of a turn (never more than $1\ 1/2$ turns)
- F. Connect acetylene hose to acetylene regulator and purge hose
- G. Connect oxygen hose to oxygen regulator and purge hose
- H. Connect torch body to oxygen and acetylene hose and close both valves on torch body
- I. Attach cutting attachment to torch body

(NOTE: The size tip is determined by the thickness of metal to be cut and the manufacturer's recommendations.)

- J. Close oxygen preheat valve on cutting attachment
- K. Turn adjusting screw on oxygen regulator clockwise until correct pressure is reached
- L. Turn adjusting screw on acetylene regulator clockwise until correct working pressure is reached
- M. Test all connections for leaks with Ivory soap suds and water
(NOTE: Apply soap suds with a clean paint brush.)

INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

JOB SHEET #2 - Turn on, Light, Adjust the Cutting Torch
to a Neutral Flame, and Turn off the Oxyacetylene
Cutting Equipment

I. Tools and materials needed

- A. Oxygen cylinder
- B. Acetylene cylinder
- C. Hoses
- D. Oxygen and acetylene regulators
- E. Torch body
- F. Cutting attachment with slip-in tip
- G. Cylinder holder and hose rack
- H. Flint lighter
- I. Wrench
- J. Gloves
- K. Safety goggles
- L. Coveralls or protective clothing

II. Procedure

- A. Check all cylinder, regulator, and torch valves to make sure they are off
- B. Open acetylene cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)
- C. Open acetylene valve on torch one turn
- D. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached*
- E. Close acetylene valve on torch
- F. Open oxygen cylinder valve all the way
- G. Open oxygen torch valve all the way
- H. Open oxygen preheat valve on cutting attachment one turn
- I. Turn adjusting screw on oxygen regulator clockwise until desired pressure is reached*
- J. Close oxygen preheat valve on cutting attachment
- K. Open acetylene valve on torch 1/4 turn
- L. Light the torch with flint lighter and adjust until smoke on flame clears

- M. Open oxygen preheat valve slowly and adjust to a neutral flame
- N. Depress the oxygen cutting lever and check to see that a neutral flame is present

(NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured.)

(*NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

III. Procedure for turning off flame and oxyacetylene unit

- A. Close acetylene valve on torch
- B. Close oxygen preheat valve
- C. Close acetylene cylinder valve
- D. Close oxygen cylinder valve
- E. Open acetylene valve on torch

(NOTE: When gauges reach 0, close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.)

- F. Open oxygen preheat valve on torch

(NOTE: When gauges reach 0, close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.)

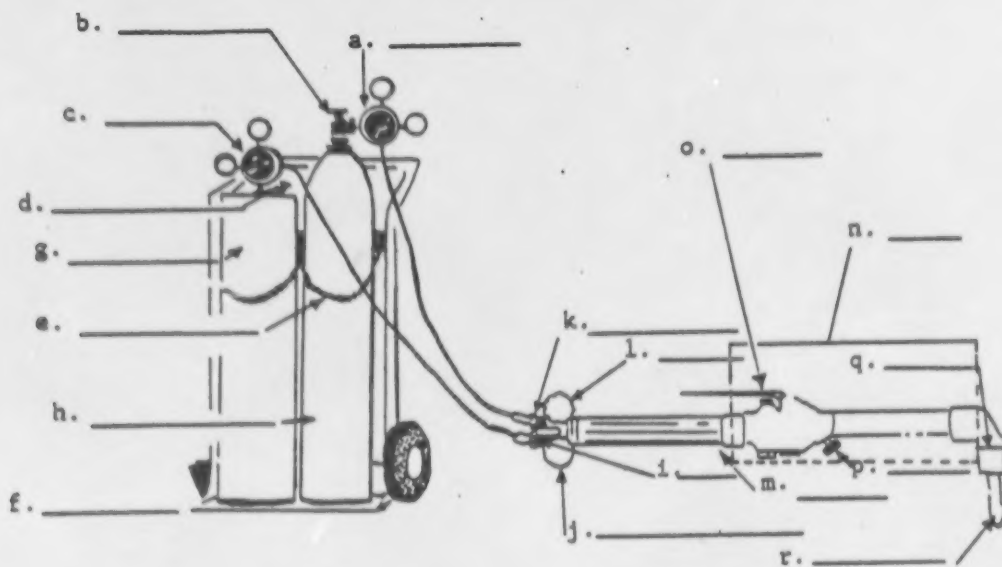
- G. Close oxygen valve on torch
- H. Place torch and hose on hanger or brackets provided

INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

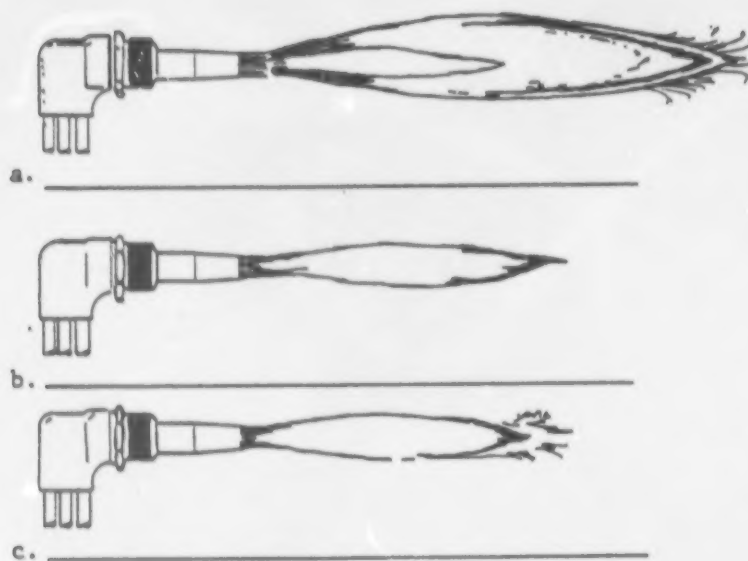
TEST

1. Define the following terms associated with oxyacetylene cutting.
 - a. Oxyacetylene cutting -
 - b. Backfire -
 - c. Purge -
 - d. Oxidation -
 - e. Flashback -
 - f. Oxide -
2. List five safety precautions to observe when handling oxyacetylene equipment.
 - a.
 - b.
 - c.
 - d.
 - e.
3. Write the characteristics of the gases used in oxyacetylene cutting
 - a. Acetylene
 - b. Oxygen
4. List the three components of a fire triangle.
 - a.
 - b.
 - c.

5. Identify the parts of oxyacetylene cutting equipment.



6. Identify the three types of flames.



7. Demonstrate the ability to:

- a. Set up the oxyacetylene cutting equipment
- b. Turn on, light, adjust to a neutral flame and turn off the oxyacetylene cutting equipment.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

INTRODUCTION TO OXYACETYLENE CUTTING
UNIT VII

ANSWERS TO TEST

1.
 - a. Oxyacetylene cutting - The severing of ferrous metal by heating and rapid oxidation of metal with pure oxygen
 - b. Backfire - A short "pop" of the torch flame followed by the extinguish of the flame or continued burning of the gases
 - c. Purge - Clear or make free of foreign material or impurities
 - d. Oxidation - Combining oxygen with another substance
 - e. Flashback - Fire burning inside the torch
 - f. Oxide - Term usually applied to rust, corrosion, coating, film, or scale

2. Any five of the following
 - a. Blow out cylinder valve (crack valve for a second) before attaching regulators
 - b. Release adjusting screw on regulator before opening cylinder valve
 - c. Stand to side of regulator when opening cylinder valve
 - d. Open cylinder valves slowly
 - e. Do not use acetylene (in free state) at pressures higher than 15 PSI
 - f. Purge oxygen and fuel gas passages (individually) before lighting torch
 - g. Light fuel gas before opening oxygen valve on torch
 - h. Use no oil on regulators, torches, fittings, etc.
 - i. Do not use oxygen as a substitute for compressed air
 - j. Keep heat, flames, and sparks away from combustibles

3.
 - a. Acetylene
 1. Colorless
 2. Has distinct odor
 3. Combustible
 - b. Oxygen
 1. Colorless
 2. Odorless
 3. Tasteless
 4. Supports and intensifies combustion

4.
 - a. Fuel
 - b. Heat
 - c. Oxygen

5.
 - a. Oxygen regulator
 - b. Oxygen cylinder valve
 - c. Acetylene regulator
 - d. Acetylene cylinder valve
 - e. Safety chain
 - f. Cylinder truck
 - g. Acetylene cylinder
 - h. Oxygen cylinder
 - i. Acetylene fitting
 - j. Acetylene torch valve
 - k. Oxygen fitting
 - l. Oxygen torch valve
 - m. Torch body
 - n. Cutting attachment
 - o. Oxygen cutting lever
 - p. Oxygen preheat valve
 - q. Tip nut
 - r. Slip-in tip

6.
 - a. Carburizing
 - b. Neutral
 - c. Oxidizing

7. Performance skills will be evaluated to the satisfaction of the instructor.

OXYACETYLENE CUTTING UNIT VIII

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to list purposes of a slag box, describe the results when a backfire and a flashback takes place, and perform cutting skills with the cutting torch by making ninety degree cuts, bevel cuts, and cutting holes in mild steel. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with oxyacetylene cutting to the correct definition.
2. Identify the parts of the torch body and cutting attachment.
3. List the purposes of a slag box.
4. List five reasons for poor cuts.
5. List four causes of a backfire.
6. Describe the results when a backfire takes place.
7. Describe the results when a flashback takes place.
8. List in the proper order the steps to follow in case of flashback.
9. Demonstrate the ability to:
 - a. Lay out a pattern on metal to be cut with the aid of a straightedge and soapstone.
 - b. Make ninety degree cuts in mild steel and restart a cut.
 - c. Make a flame beveled cut on mild steel plate.
 - d. Cut a hole in mild steel.

OXYACETYLENE CUTTING
UNIT VIII

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with objective sheet
2. Provide students with information and job sheets
3. Make transparencies
4. Discuss terminal and specific objectives
5. Discuss information sheet
6. Demonstrate and discuss procedures outlined in job sheets
7. Give test

Student:

1. Read objective sheet
2. Study information sheet
3. Demonstrate the ability to accomplish the procedures outlined in the job sheets
4. Take test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information sheet
3. Transparency master
TM 1--Parts of a Torch Body and Cutting Attachment
4. Job sheets
Job Sheet #1--Lay out a Pattern on Mild Steel Plate
Job Sheet #2--Make Ninety Degree Cuts on Mild Steel and
Restart a Cut
Job Sheet #3--Make a Flame Beveled Cut on Mild Steel Plate
Job Sheet #4--Cut a Hole in Mild Steel
5. Test
6. Answers to test

References:

1. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch.
Modern Welding. Homewood, Illinois: Goodheart-Willcox Co., Inc.
1970.
2. Phipps, Lloyd J., H.F. McColly, L.L. Scranton, and G.C. Cook.
Farm Mechanics Text and Handbook. Danville, Illinois: Inter-
state Printers and Publishers, Inc.

3. Smith's Short Course for Gas Cutting, Welding, and Brazing.
Minneapolis, Minnesota: Education Department of Smith Welding
Equipment, Division of Tescom Corporation.
4. The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and
Cutting Procedure. New York: Union Carbide Corpacration, Linde
Division.

OXYACETYLENE CUTTING
UNIT VIII

INFORMATION SHEET

I. Term and definitions

A. Flashback--Fire inside torch

(CAUTION: This is a very dangerous condition.)

B. Backfire--Momentary burning back of the flame into the tip

(NOTE: This is usually accompanied by a loud pop and extinguishing of the flame.)

C. Flame cutting--A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch

(NOTE: As the metal is oxidized, the preheat flame maintains the temperature necessary to keep the oxidation process going in a narrow zone across the length of the base metal.)

D. Slag box--Metal container with a layer of water or sand to catch hot slag

E. Drag line--Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

F. Kerf--Area where the metal was removed in the form of an oxide during the cutting process

G. Oxide--Term usually applied to rust, corrosion, coating, film, or scale

(NOTE: Oxygen combines with the metal causing oxides.)

H. Oxidation--Combining oxygen with another substance

Example: A metal is oxidized when the metal is cut

II. Parts of a cutting torch and tip (Transparency 1)

A. Cutting torch

1. Oxygen fitting
2. Acetylene fitting
3. Oxygen torch valve
4. Acetylene torch valve

5. Torch body
6. Oxygen cutting lever
7. Oxygen preheat valve
8. Tip nut
9. Slip-in tip

B. Cutting tip

1. Preheat orifice--Heats metal to kindling point (cherry red) of approximately 1600° F.
2. Cutting orifice--Remove oxidized metal

(NOTE: The selection of the correct tip for the job is determined by the thickness of metal, size of tip orifices, and the oxygen cutting pressures. See Manufacturer's recommendations.)

III. Purposes of slag box

- A. To catch hot slag
- B. To prevent fire
- C. To protect clothing
- D. To protect welding hoses

IV. Reasons for poor cuts

- A. This is a correctly made cut in 1 inch plate; the edge is square and the draglines are essentially vertical and not too pronounced



- B. Preheat flames were too small for this cut with the result that the cutting speed was too slow, causing bad gouging at the bottom



- C. Preheat flames were too long with the result that the top surface has melted over, the cut edge is irregular, and there is an excessive amount of adhering slag



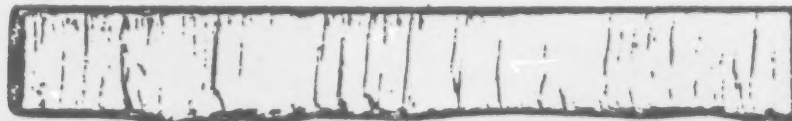
- D. Oxygen pressure was too low with the result that the top edge has melted over because of the too slow cutting speed



- E. Oxygen pressure was too high and the nozzle size too small with the result that the entire control of the cut has been lost



- F. Cutting speed was too slow with the result that the irregularities of the draglines are emphasized



- G. Cutting speed was too high with the result that there is a pronounced break to the dragline and the cut edge is irregular



- H. Blowpipe travel was unsteady with the result that the cut edge is wavy and irregular



- I. Cut was lost and not carefully restarted with the result that bad gouges were caused at the restarting point



V. Causes of backfire

- A. Insufficient acetylene or oxygen pressure
- B. Loose cutting tip
- C. Dirty tip
- D. Overheating of cutting tip
- E. Bad O-ring in torch body

(NOTE: The above causes should be carefully checked to control backfire.)

VI. Results of a backfire

- A. Flame burns momentarily back into tip
- B. A loud snap or pop results
 - 1. Flame may go out
 - 2. Flame may continue to burn in normal manner

VII. Results of flashback

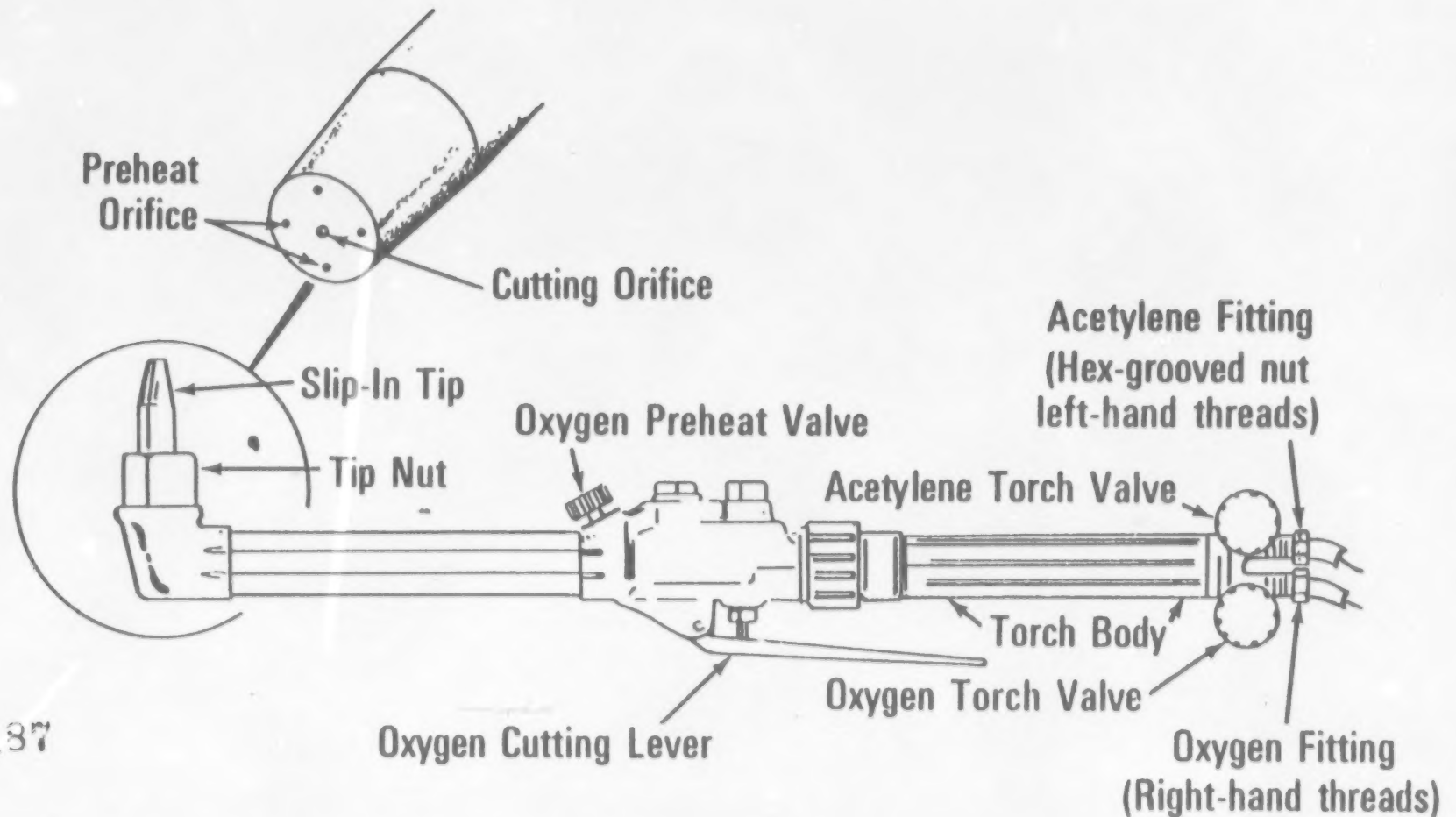
- A. Fire inside torch
- B. Disappearance of flame followed by
 - 1. Squealing or hissing noise inside torch
 - 2. Sparks coming from the torch
 - 3. Smoke coming from the torch

VIII. Steps to follow in case of flashback

- A. Close oxygen preheat valve
- B. Close oxygen torch valve
- C. Close acetylene torch valve
- D. Release oxygen regulator screw
- E. Release acetylene regulator screw
- F. Examine acetylene unit
- G. Reset regulator pressures
- H. Light torch

(NOTE: If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, shut off the oxygen cylinder valve and the acetylene cylinder valve, then notify your instructor.)

Parts of a Torch Body and Cutting Attachment



OXYACETYLENE CUTTING
UNIT VIII

JOB SHEET #1—LAY OUT A PATTERN ON MILD STEEL PLATE

I. Tools and materials needed

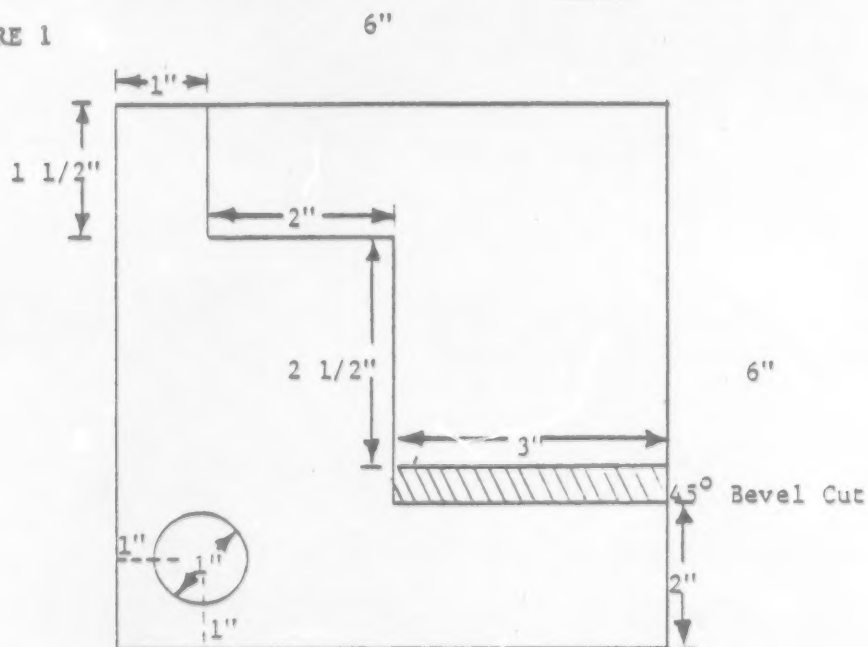
- A. Square and straightedge
- B. Soapstone
- C. Mild steel plate $1/4"$ to $1/2"$ thick, 6" square
- D. Gloves
- E. Safety goggles
- F. Coveralls or protective clothing

II. Procedure

- A. Select starting point
- B. Measure distances and mark
- C. Complete drawing and turn in to instructor for evaluation (Figure 1)

(NOTE: Instructor may have the students cut out the pattern once it has been approved.)

FIGURE 1



OXYACETYLENE CUTTING
UNIT VIII

JOB SHEET #2--MAKE NINETY DEGREE CUTS ON MILD STEEL
AND RESTART A CUT

I. Tools and materials needed

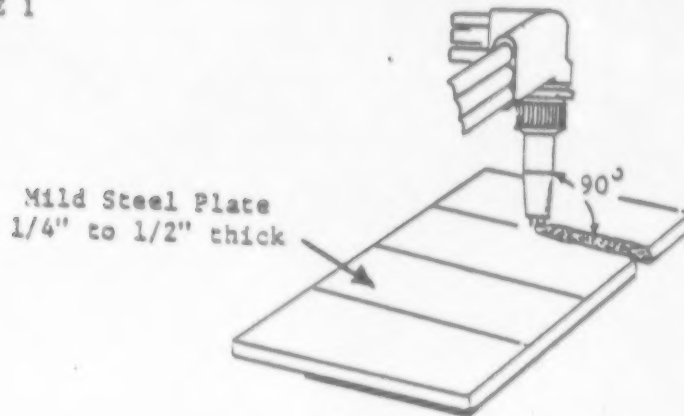
- A. Cutting outfit with tip assembly
- B. Mild steel plate 1/4" to 1/2" thick, 4" wide or wider, 8" long or longer
- C. Soapstone with a sharp point or edge
- D. Straightedge
- E. Gloves
- F. Safety goggles
- G. Pliers
- H. Coveralls
- I. Flint lighter
- J. Welding or cutting table
- K. Slag box
- L. Can of water
- M. Cutting tip

II. Procedure

- A. Mark four parallel lines 2" apart on plate to be cut
- B. Adjust oxygen regulator
- C. Adjust acetylene regulator
- D. Place plate to be cut over slag box
- E. Light torch
- F. Adjust to neutral flame
- G. Assume comfortable position

- H. Place hoses behind operator
- I. Maneuver torch with both hands
- J. Hold preheat flame with tip of inner cone $1/16''$ to $1/8''$ above top of plate at right edge until red spot appears
- K. Depress the oxygen cutting lever, and move from right to left across the plate (for left-handed operators, go from left to right) Figure 1

FIGURE 1



- L. Hold the tip at right angles to work while cutting with inner cone being $1/16''$ to $1/8''$ above work
 - M. Make 90° cuts until you have developed the proper procedure
 - N. Cool metal by placing in can of water with the aid of pliers
 - O. Show samples to instructor for approval and grading
- III. Procedure for restarting a cut
- A. Release the oxygen cutting lever
 - B. Preheat edge (only) where cutting action was stopped
 - C. Slowly depress oxygen cutting lever and continue cut

OXYACETYLENE CUTTING
UNIT VIII

JOB SHEET #3--MAKE A FLAME BEVELED CUT ON MILD STEEL PLATE

I. Tools and materials needed

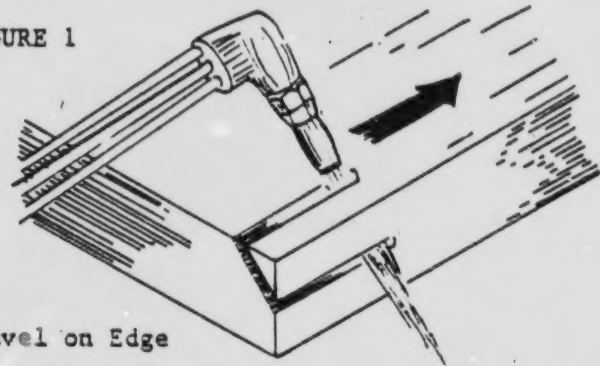
- A. Cutting outfit with tip assembly
- B. Mild steel plate $1/4"$ to $1/2"$ thick, 4" wide or wider, 8" long or longer
- C. Soapstone with a sharp point or edge
- D. Straightedge
- E. Gloves
- F. Safety goggles
- G. Pliers
- H. Flint lighter
- I. Welding or cutting table
- J. Slag box
- K. Can of water
- L. Cutting tip

II. Procedure

- A. Place one piece of $3/8"$ to $1/2"$ plate 2" x 6" on slag box or cutting table
- B. Light and adjust cutting torch to a neutral flame
(NOTE: Oxygen cutting pressures are greater for bevel cuts than 90° cuts.)
- C. Place hoses behind operator

- D. Hold torch with both hands at desired angle to metal as shown (Figure 1)

FIGURE 1



- E. Hold preheat flame with tip of inner cone (neutral flame) $1/16''$ to $1/8''$ above top of plate until bright red spot appears
- F. Depress oxygen cutting lever and proceed across plate with very consistent movement being careful to maintain constant travel speed, torch angle, and flame to work distance
- G. Practice until you develop the proper procedure
- H. Turn in exercises for instructor's approval and grading

OXYACETYLENE CUTTING
UNIT VIII

JOB SHEET #4--CUT A HOLE IN MILD STEEL

I. Tools and materials needed

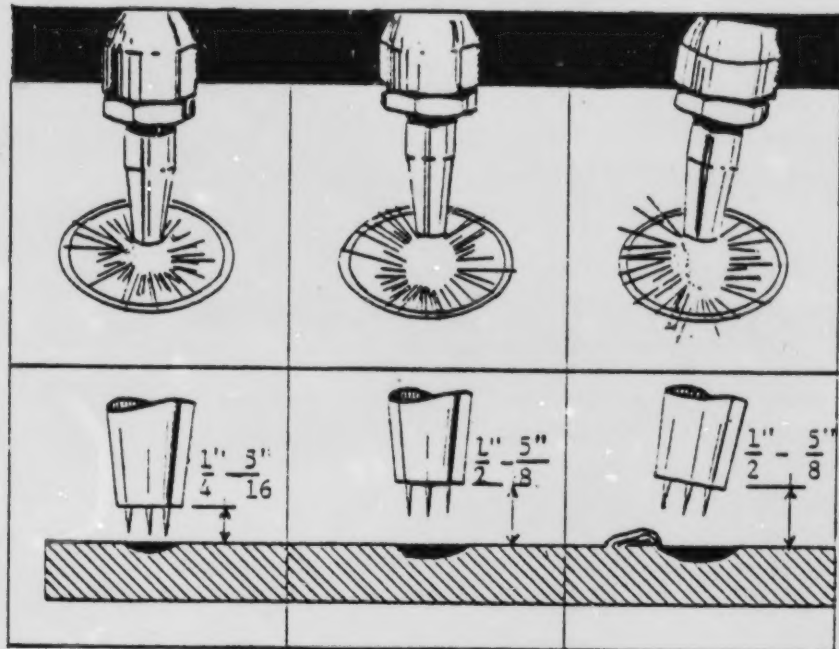
- A. Cutting outfit with tip
- B. Mild steel plate
- C. Soapstone with a sharp point or edge
- D. Straightedge
- E. Gloves
- F. Safety goggles
- G. Pliers
- H. Coveralls
- I. Flint lighter
- J. Welding or cutting table
- K. Slag box
- L. Can of water

II.- Procedure

- A. Draw two circles on metal
 - 1. 1" in diameter, 1" from edge
 - 2. 1/2" in diameter, 1" from edge
- B. Adjust oxygen regulator
- C. Adjust acetylene regulator
- D. Place metal to be cut over slag box
- E. Light torch
- F. Adjust to neutral flame
- G. Assume comfortable position
- H. Place hoses behind operator

- I. Maneuver torch with both hands
- J. Hold tip of inner cone $\frac{1}{16}$ " to $\frac{1}{8}$ " above point to be cut until metal turns bright red (Figure 1)

FIGURE 1

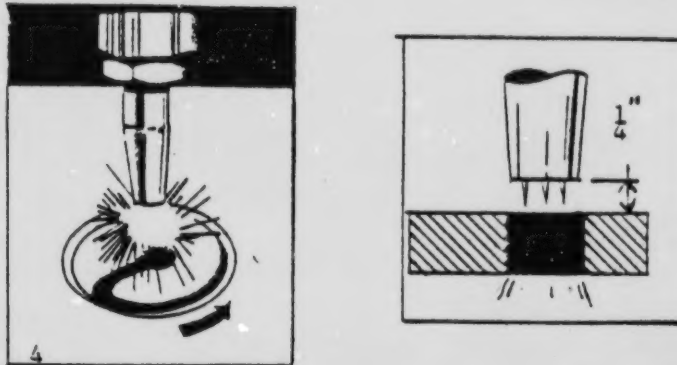


1. Tilt torch 15° from vertical position
(NOTE: This will allow molten metal to be blown away from operator.)
2. Depress oxygen cutting lever slowly moving torch backwards (to the operator's right if right-handed) until cut pierces plate

K. Return cutting torch to vertical position

1. Raise cutting tip until tip of inner cone is from $\frac{1}{4}$ " to $\frac{1}{2}$ " above the plate
2. Make cut (Figure 2)

FIGURE 2



- L. Cut just inside soapstone mark until circular cut is completed
- M. Repeat steps K and L until all holes are cut
- N. Cool metal by placing in can of water with the aid of pliers
- O. Show samples to instructor for approval and grading

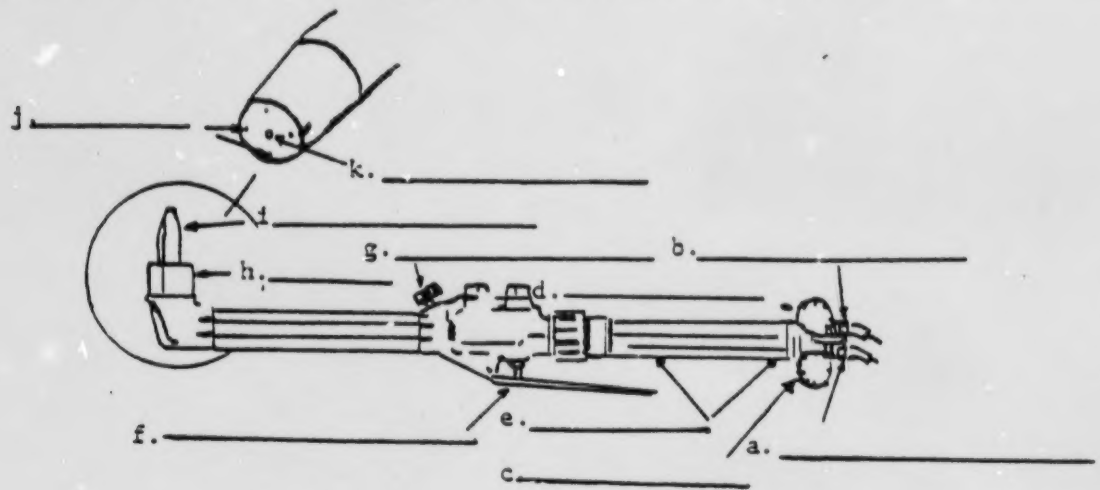
OXYACETYLENE CUTTING
UNIT VIII

TEST

1. Match terms on the right to the correct definition.

- | | |
|--|------------------|
| _____ a. Metal container with a layer of water or sand to catch hot slag | 1. Flashback |
| _____ b. Area where the metal was removed in the form of an oxide during the cutting process | 2. Backfire |
| _____ c. Combining oxygen with another substance | 3. Flame cutting |
| _____ d. Fire inside torch | 4. Slag Box |
| _____ e. Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip | 5. Drag line |
| _____ f. Momentary burning back of the flame into the tip | 6. Kerf |
| _____ g. Term usually applied to rust, corrosion, coating, film, or scale | 7. Oxide |
| _____ h. A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch | 8. Oxidation |

2. Identify the parts of the torch body and cutting attachment.



3. List the purposes of a slag box.

- a.
- b.
- c.
- d.

4. List five reasons for poor cuts.

- a.
- b.
- c.
- d.
- e.

5. List four causes of a backfire.

- a.
- b.
- c.
- d.

6. Describe the results when a backfire takes place.

7. Describe the results when a flashback takes place.

8. List in the proper order the steps to follow in case of a flashback.

a.

b.

c.

d.

e.

f.

g.

h.

9. Demonstrate the ability to:

a. Lay out a pattern on metal to be cut with the aid of a straightedge and soapstone.

b. Make 90° cuts on mild steel and restart a cut.

c. Make a flame beveled cut on mild steel plate.

d. Cut a hole in mild steel.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

OXYACETYLENE CUTTING
UNIT VIII

ANSWERS TO TEST

1. a. 4 e. 5
 b. 6 f. 2
 c. 8 g. 7
 d. 1 h. 3
2. a. Oxygen fitting
 b. Acetylene fitting
 c. Oxygen torch valve
 d. Acetylene torch valve
 e. Torch body
 f. Oxygen cutting lever
 g. Oxygen preheat valve
 h. Tip nut
 i. Slip-in tip
 j. Preheat orifice
 k. Cutting orifice
3. a. To catch hot slag
 b. To prevent fire
 c. To protect clothing
 d. To protect welding hoses
4. Any five of the following:
 a. Preheat flames too small causing cutting speed to be too slow
 b. Preheat flames too long

- c. Oxygen pressure too low
 - d. Oxygen pressure too high and nozzle size too small
 - e. Cutting speed too slow
 - f. Cutting speed too high
 - g. Blowpipe travel unsteady
 - h. Cut lost and not carefully restarted
5. Any four of the following:
- a. Insufficient acetylene or oxygen pressure
 - b. Loose cutting tip
 - c. Dirty tip
 - d. Overheating of cutting tip
 - e. Bad O-ring in torch body
6. Description should include:
- a. Flame burns momentarily back into tip
 - 1. Flame may go out
 - 2. Flame may continue to burn in normal manner
7. Description should include:
- a. Fire inside torch
 - b. Disappearance of flame followed by:
 - 1. Squealing or hissing noise inside torch
 - 2. Sparks coming from torch
 - 3. Smoke coming from torch
8. a. Close oxygen preheat valve
- b. Close oxygen torch valve
- c. Close acetylene torch valve
- d. Release oxygen regulator screw

- e. Release acetylene regulator screw
 - f. Examine acetylene unit
 - g. Reset regulator pressures
 - h. Light torch
9. Performance skills will be evaluated to the satisfaction of the instructor.

SERVICING THE TRACTOR--COOLING SYSTEM
UNIT X

TERMINAL OBJECTIVE

After completion of Unit X, the student should be able to match terms associated with servicing the cooling system of farm tractors and identify the parts of the cooling system. The student should be able to match the type corrosion and deposits with the probable cause and demonstrate the ability to flush or clean the cooling system and test the pressure of a cooling system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with servicing the farm tractor's cooling system.
2. Identify the parts of a tractor's cooling system.
3. List three jobs that the cooling system must perform.
4. Select from a list the reasons a pressure type radiator cap is used with forced circulation cooling system.
5. Select from a list the reasons a permanent antifreeze solution should be used in a cooling system at all times.
6. List the problems that result when an engine overheats.
7. Match the type corrosion and deposits found in a cooling system with the probable cause.
8. Name two ways to protect a cooling system from rust.
9. Demonstrate the ability to:
 - a. Flush or clean the cooling system.
 - b. Pressure test the cooling system.

SERVICING THE TRACTOR--COOLING SYSTEM
UNIT X

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in the job sheets.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
 - 1. TM 1 - Cooling System Components
 - 2. TM 2 - Pressure-Type Radiator Cap
- D. Job sheets
 - 1. Job Sheet #1 - Flushing or Cleaning the Cooling System
 - 2. Job Sheet #2 - Pressure Testing the Cooling System
- E. Test
- F. Answers to test

II. References:

- A. Tractor Maintenance. American Association for Vocational Instructional Materials, Engineering Division, Athens, Georgia 30601: Foote and Davis (Division of McCall Printing Co.), 1970.
- B. Auto Mechanics Instructional Units. Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, Stillwater, Oklahoma, 1971.
- C. Getting the Most From Your Tractor. Cooperative Extension Service KSU. Manhattan, Kansas 66506 XE-M14

SERVICING THE TRACTOR--COOLING SYSTEM
UNIT X

INFORMATION SHEET

I. Terms and definitions

- A. Water pump - A centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system.
- B. Water jacket - The passages through the block and cylinder head that allows the coolant to circulate around the cylinders, valves, and combustion chambers
- C. Radiator - A device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air
- D. Fan - The device generally mounted on the water pump hub assembly used to pull a large volume of air through the openings in the radiator core
- E. Shroud - A funnel-like structure attached to the radiator and extending around and behind the fan used to make the fan more effective in pulling air through the radiator
- F. Thermostat - A heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator
- G. Pressure cap - A cap which increases the pressure within the cooling system several pounds per square inch allowing the coolant to circulate at higher temperatures without evaporation or surge loss
- H. Radiator hose - The hose used to connect the radiator to the engine
- I. V-Belt - The belt turned by a pulley on the front of the crankshaft used to drive the water pump, fan, and other engine accessories

II. Parts of a cooling system (Transparency 1)

III. Jobs the cooling system performs

- A. Removes surplus or unwanted heat
- B. Maintains an efficient temperature under all operating conditions

- C. Brings an engine, when started, up to operating temperature as soon as possible
- IV. Reasons a pressure type radiator cap is used with forced circulation cooling systems
 - A. Makes it possible for the tractor to operate at high temperatures
(NOTE: Water at a temperature of 185 degrees F. to 195 degrees F. is so hot it tends to vaporize readily. Without a pressure cap, water vapor would be free to pass through the overflow tube and you would probably have to refill the radiator several times a day. With a pressure cap the vapor is held inside the radiator.)
 - B. It acts as a pressure-release valve (Transparency 2)
(NOTE: If the pressure in the radiator gets above the pressure exerted by the spring, the cap permits air or vapor or both to pass into the upper section and out through the overflow tube.)
 - C. Vacuum valve fits in the center of the pressure-release valve and allows air to enter the radiator when the coolant cools
(NOTE: Without a vacuum valve, a vacuum would develop when the engine cools causing the radiator hoses to collapse and air leaks to develop around the water-pump shaft and any weak spots in the radiator.)
- V. Reasons for using a permanent type antifreeze
 - A. Prevents coolant from freezing
 - B. Boiling point of permanent antifreeze is higher than water
 - C. Reduces the corrosive action of water
(NOTE: Additives to permanent type antifreezes deteriorate with time and must be changed after two years.)
- VI. Problems that result when an engine overheats
 - A. Sticking and burned valves
 - B. A cracked engine head or block
 - C. Excessive knock
(NOTE: Excessive knock is a result of hot spots that develop and cause incoming fuel to ignite before the spark plug fires.)
- VII. Causes of corrosion and deposits found in a cooling system
 - A. Mineral deposits - Result from repeated additions of hard water that contains alkali (live or magnesium) or minerals (iron)

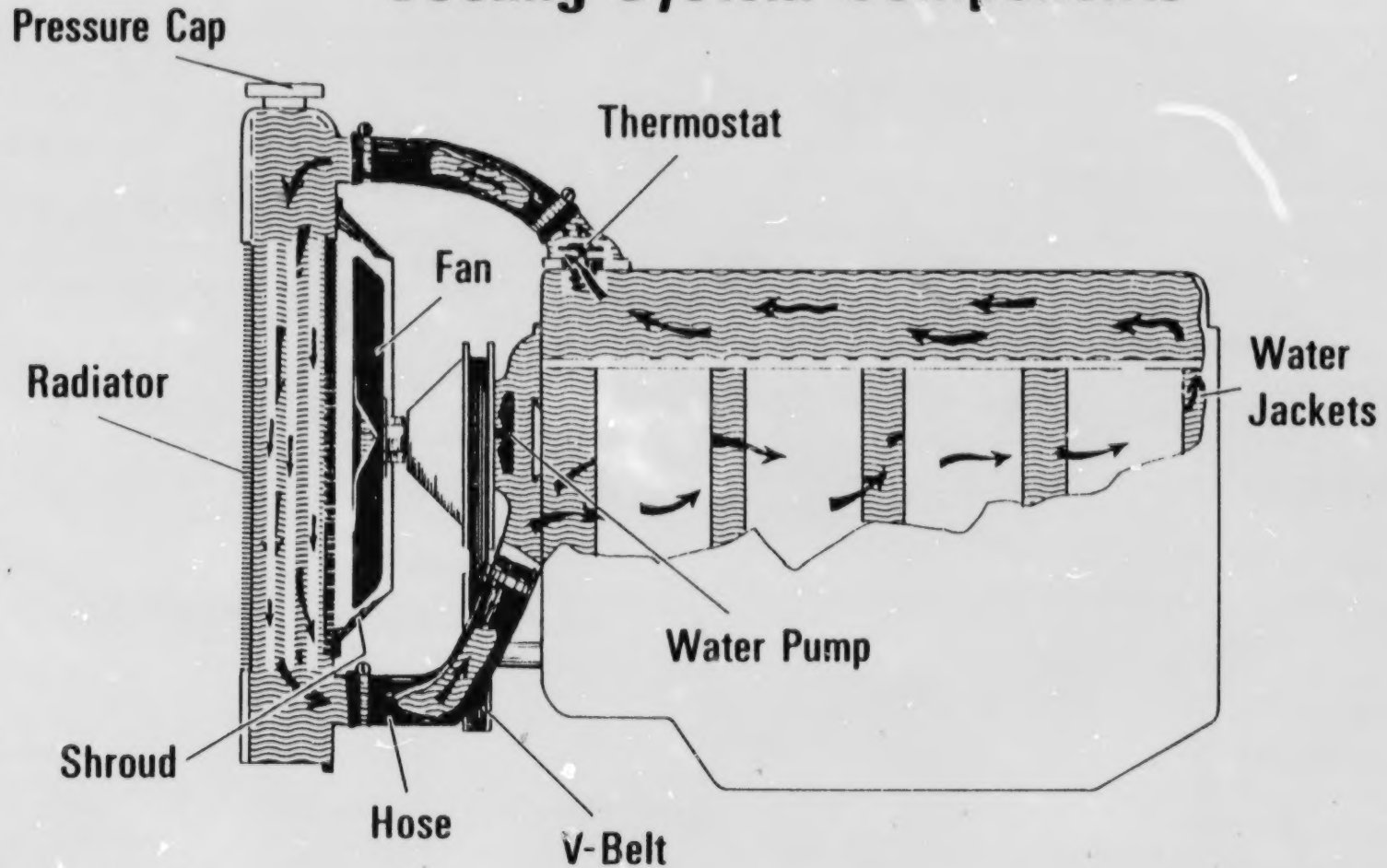
- B. Rust - When water and oxygen are both present, there is a natural tendency for iron parts in the cooling system to rust
- C. Galvanic corrosion - (sometimes called electrolytic corrosion)
Caused by small electric currents that are set up where two or more different metals are in contact in the cooling system
(NOTE: This action is similar to that of a flashlight battery in which certain metal parts are gradually eaten away and perforated.)

VIII. Protecting a cooling system from rust

- A. Use a chemical inhibitor that combines with the metal surface to give a protective coating
- B. Use a soluble-oil inhibitor which settles out of the water and provides protection by coating the surfaces in the cooling system

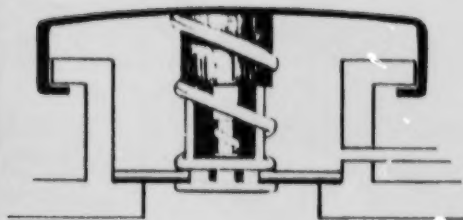
(NOTE: Some manufacturers include both types of protection in their anti-rusts.)

Cooling System Components



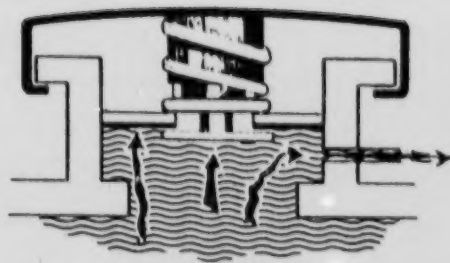
Pressure Type Radiator Caps

Normal Operation



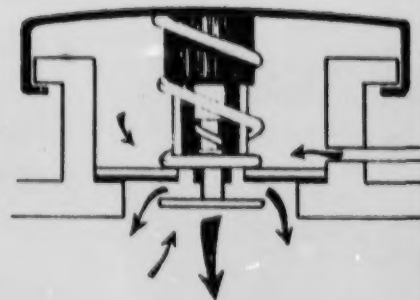
Valves Closed

Excessive Pressure



Pressure Valve Open

Cooling-Off Period



Vacuum Valve Open

SERVICING THE TRACTOR--COOLING SYSTEM
UNIT X

JOB SHEET #1 - Flushing or Cleaning the Cooling System

I. Tools and materials needed

- A. Commercial flushing compound - Used when system is in good condition
- B. Commercial cooling system cleaner - Used when there is considerable evidence of scale and rust
- C. Cardboard or blanket to reduce air flow through radiator
- D. Water supply
- E. Adjustable pliers
- F. Screwdriver

II. Procedure

(NOTE: The procedures are determined by the chemicals being used.)

A. Read the instructions on the container

(NOTE: You may be able to add the contents directly to the present coolant. If antifreeze is in the cooling system, the instructions may indicate that the coolant be drained and replaced with water.)

- 1. If cleaner or flushing compound is to be added to present coolant, proceed with step B
- 2. If present coolant should be replaced with water, proceed with the following substeps:

a. Run engine until thoroughly warmed

(NOTE: When engine is warmed enough, the thermostat valve is open and will allow more complete drainage. Cover radiator to be certain engine warms.)

b. Completely drain cooling system while engine is still warm

(NOTE: Some tractors have only one drain cock but most have two or three--one on the radiator and one or two on the engine block.)

c. Close drain cocks

d. Refill cooling system with water

(NOTE: If engine is hot, allow it to cook, then add water slowly to avoid cracking engine block or head. Allow enough space to add the flushing compound or cleaner without causing the coolant to overflow. Temperature of water being added should approximately be the temperature of the engine.)

B. Add flush compound or cleaner

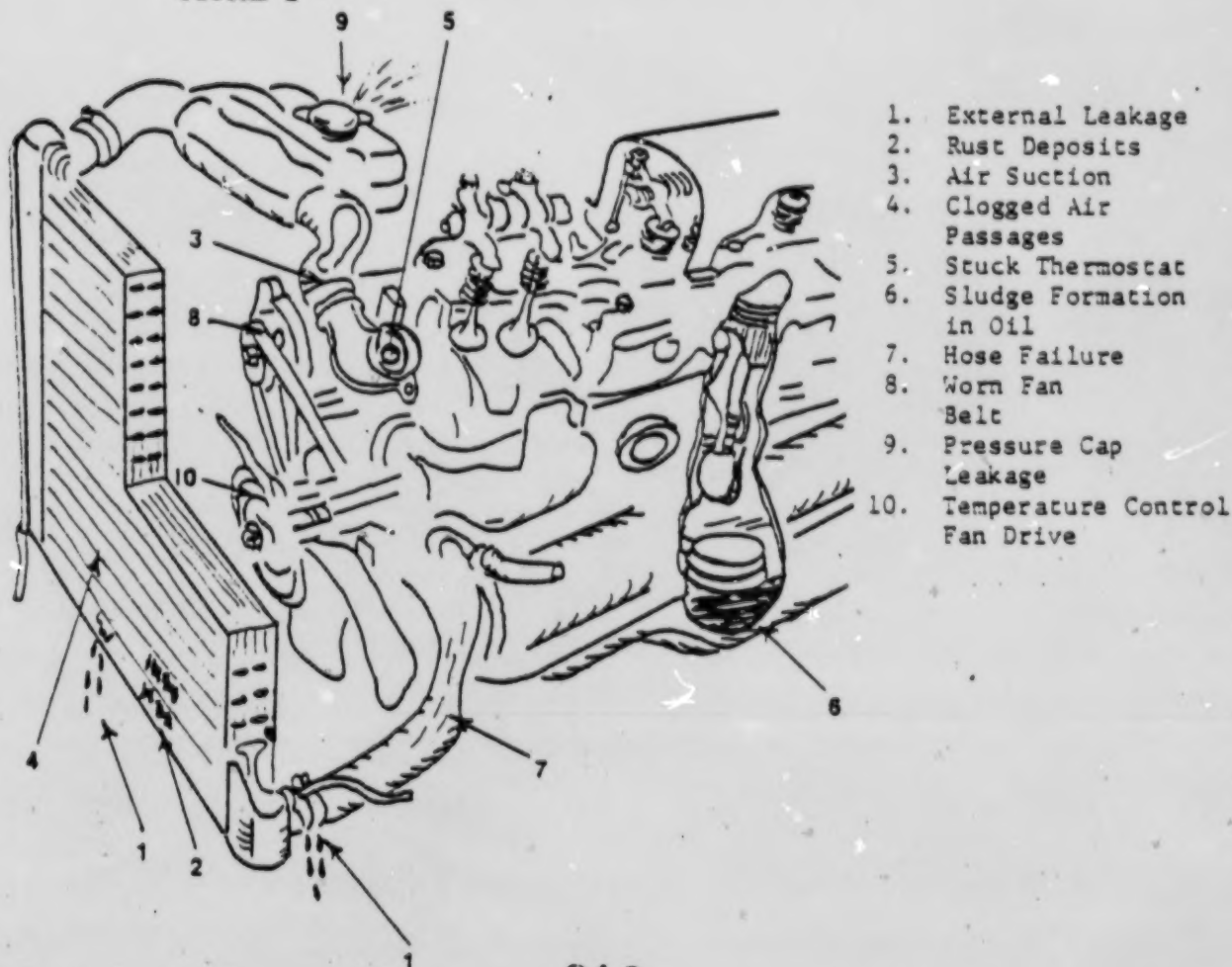
C. Start engine and operate until normal operating temperature is reached

(NOTE: Cover the engine so it will heat quickly and completely. Do not allow the coolant to boil.)

D. Check external condition of cooling system (Figure 1)

(NOTE: Illustration enclosed indicates points that should be checked.)

FIGURE 1



(NOTE: Most of these checks can be made while the engine is operating. If leak is found that can not be fixed with a new hose or by tightening a hose clamp, the tractor should be taken to a competent repairman.)

- E. Completely drain cooling system
- F. If acid-base cleaner was used be sure to use a neutralizer
 - 1. Add neutralizer provided and fill cooling system
 - 2. Run engine about ten minutes, then drain
 - 3. Flush cooling system with water
- G. Refill with coolant
 - 1. Use clean soft water and a rust inhibitor or new antifreeze solution with soft water
(NOTE: Do not use old antifreeze with a new can of rust inhibitor. Because of different chemical compounds used for rust inhibitors the new and old antifreeze inhibitors may offset each other so neither is effective.)
 - 2. If you install antifreeze refer to the operator's manual for the cooling system capacity of your tractor
- H. Clean radiator externally by using compressed air or water
(NOTE: Compressed air or water should be applied from fan side of radiator.)

SERVICING THE TRACTOR—COOLING SYSTEM
UNIT X

JOB SHEET #2 - Pressure Testing the Cooling System

I. Tools and materials needed

- A. Radiator pressure tester

II. Procedure

- A. Remove radiator cap

(CAUTION: Never remove the radiator cap quickly when the engine is hot. If cap must be removed when hot, loosen cap to first stop and leave in this position until all pressure is released. Cap can then be removed safely.)

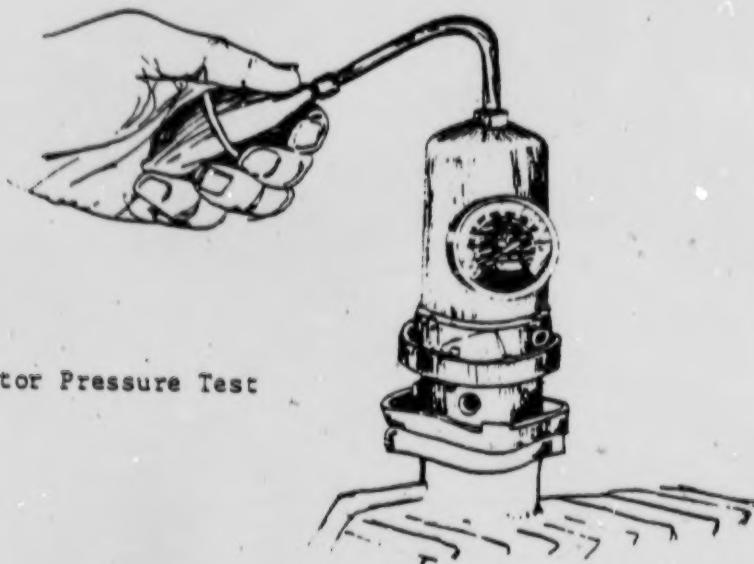
- B. Wipe the radiator filler cap seat clean

- C. Attach the radiator pressure tester

- D. Apply pressure

(NOTE: Pressure applied should not exceed recommended cooling system pressure by more than 1 psi.) (Figure 1)

FIGURE 1



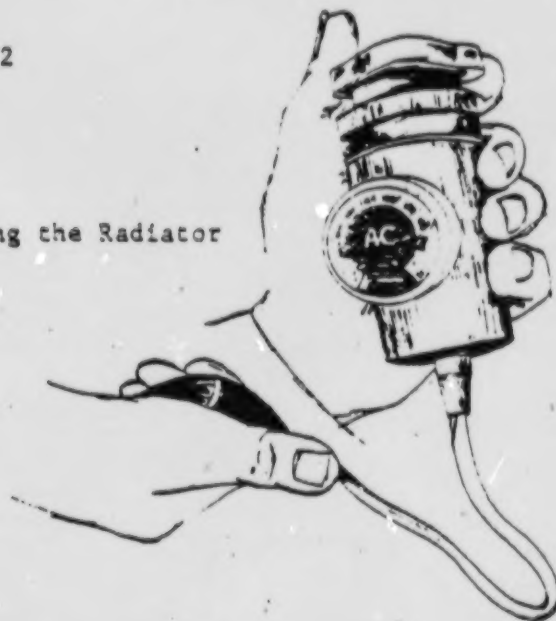
Radiator Pressure Test

- E. Make sure pressure holds steady--Indicates cooling system is not leaking

- F. Check to see if pressure drops
(NOTE: Check for external leaks--hose connections, expansion plugs, water pump, and radiator.)
- G. Watch to see if pressure drops, but external leaks are not visible
(NOTE: Remove tester; start and run engine until operating temperature is reached.)
- H. Re-attach tester and apply cooling system pressure
- I. Increase engine speed to half throttle
- J. If pressure needle fluctuates, this indicates a combustion leak
- K. If pressure meter needle does not fluctuate, sharply accelerate engine several times and check for a discharge of water from the tailpipe
(NOTE: If an abnormal amount of water is discharged at the tailpipe, this could indicate a cracked block or head or a defective head gasket. Check radiator for loss of coolant on tractors having vertical slack or exhaust.)
- L. Test the pressure cap
(NOTE: Use same tester with adapter to test cap. If the cap does not hold the rated pressure, it should be replaced.)
(Figure 2)

FIGURE 2

Testing the Radiator
Cap



- M. With test completed, check coolant level and reinstall cap

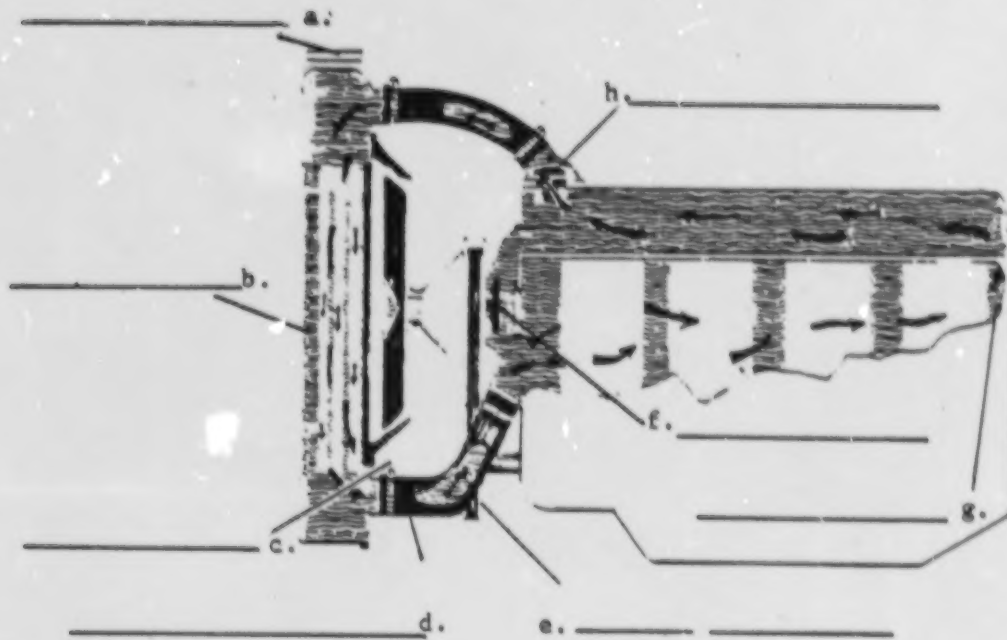
SERVICING THE TRACTOR--COOLING SYSTEM
UNIT X

TEST

1. Match the terms on the right to the proper definition.

- | | |
|---|------------------|
| _____ a. A centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system | 1. Water pump |
| _____ b. The belt turned by a pulley on the front of the crank shaft used to drive the water pump, fan, and other engine accessories | 2. Water jackets |
| _____ c. A heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator | 3. Radiator |
| _____ d. The hose used to connect the radiator to the engine | 4. Fan |
| _____ e. A cap which increases the pressure within the cooling system several pounds per square inch allowing the coolant to circulate at higher temperatures without evaporation or surge loss | 5. Shroud |
| _____ f. A funnel-like structure attached to the radiator and extending around and behind the fan used to make the fan more effective in pulling air through the radiator | 6. Thermostat |
| _____ g. The passages through the block and cylinder head that allow the coolant to circulate around the cylinders, valves, and combustion chambers | 7. Pressure cap |
| _____ h. A device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air | 8. Radiator hose |
| _____ i. The device generally mounted on the water pump hub assembly used to pull a large volume of air through the openings in radiator core | 9. V-Belt |

2. Identify the parts to the cooling system using the illustration below.



3. List three jobs that the cooling system must perform.

- a. _____
- b. _____
- c. _____

4. Select from the list below the reasons a pressure-type radiator cap is used with forced circulation cooling systems. Place an "X" by the proper answers.

- ☐ a. Makes it possible for the tractor to operate at a low temperature
- ☐ b. It acts as a pressure-release valve
- ☐ c. Vacuum valve fits in the center of the pressure-release valve and allows air to enter the radiator when the coolant cools
- ☐ d. Prevents water from going out overflow tube

5. Select from the list below the reasons a permanent antifreeze solution should be used at all times in a cooling system. Place an "X" by correct answers.

- ☐ a. Prevents coolant from freezing
- ☐ b. Boiling point of permanent antifreeze is lower than water
- ☐ c. Reduces the corrosive action of water
- ☐ d. Prevents coolant from boiling

6. List two problems that result when an engine overheats.

a.

b.

7. Match the type corrosion and deposits on the right with the correct cause of each.

- | | |
|---|-----------------------|
| ☐ a. When water and oxygen are both present, there is a tendency for iron parts in the cooling system to rust | 1. Galvanic corrosion |
| ☐ b. Result from repeated additions of hard water that contains alkali (lime or magnesium) or minerals (iron) | 2. Rust |
| ☐ c. Caused by small electric currents that are set up where two or more different metals are in contact in the cooling system | 3. Mineral deposits |

8. Name two ways to protect a cooling system from rust.

a.

b.

9. Demonstrate the ability to:

a. Flush or clean the cooling system

b. Pressure test the cooling system

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SERVICING THE TRACTOR--COOLING SYSTEM
UNIT X

ANSWERS TO TEST

1.
 - a. 1
 - b. 9
 - c. 6
 - d. 8
 - e. 7
 - f. 5
 - g. 2
 - h. 3
 - i. 4

2.
 - a. Pressure cap
 - b. Radiator
 - c. Shroud
 - d. Hose
 - e. V-Belt
 - f. Water pump
 - g. Water jackets
 - h. Thermostat

3.
 - a. Removes surplus or unwanted heat
 - b. Maintains an efficient temperature under all operating conditions
 - c. Brings an engine, when started, up to operating temperature as soon as possible

4.
 - b
 - c
 - d

5. a
c
6. Any two of the following:
 - a. Sticking and burned valves
 - b. A cracked engine head or block
 - c. Excessive knock
7. a. 2
b. 3
c. 1
8. a. Use a chemical inhibitor that combines with the metal surface to give a protective coating
b. Use a soluble-oil inhibitor which settles out of the water and provides protection by coating the surfaces in the cooling system
9. Performance skills will be evaluated to the satisfaction of the instructor.

SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

TERMINAL OBJECTIVE

After completion of Unit IV, the student should be able to distinguish between the two common types of air cleaners, discuss in writing the importance of proper air-cleaner maintenance, and list the methods of cleaning the filter element. The student should demonstrate the ability to remove and clean the dry-type air cleaner and disassemble and service the oil-bath air cleaner. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Distinguish between the two common types of air cleaners when given the characteristics of each.
2. List the advantages of a dry-type air cleaner over an oil-bath cleaner.
3. Discuss in writing the importance of proper air-cleaner maintenance.
4. Select from a list the differences between dry-type air cleaners found in tractors and those found in automobiles.
5. List the methods of cleaning the filter element.
6. Demonstrate the ability to:
 - a. Remove and clean the dry-type air cleaner.
 - b. Disassemble and service the oil-bath air cleaner.

SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss procedures outlined in the job sheet.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheet
- C. Transparency masters
 - 1. TM 1 - Oil-Bath Air Cleaner
 - 2. TM 2 - Dry-Type Air Cleaner
- D. Job sheets
 - 1. Job Sheet #1 - Removing the Dry-Type Air Cleaner
 - 2. Job Sheet #2 - Cleaning the Dry-Type Air Cleaner
 - 3. Job Sheet #3 - Servicing the Oil-Bath Air Cleaner
- E. Test
- F. Answers to test

II. References:

- A. American Association for Agricultural Engineering and Vocational Agriculture. Tractor Maintenance. Athens, Georgia: Foote and Davis (Division of McCall Printing Company), 1970.
- B. American Association for Agricultural Engineering and Vocational Agriculture. Tractor Operation and Daily Care. Athens, Georgia: Foote and Davis (Division of McCall Printing), 1970.
- C. Getting the Most From Your Tractor, Cooperative Extension Service KSU; Manhattan, Kansas 66506 XE-M14

SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

INFORMATION SHEET

I. Two common types of air cleaners

A. Oil-bath types (Transparency 1)

1. Depends on washing the air free of dust particles by pulling it through a bath of oil
2. Oil-bath cleaner should be serviced daily
3. Operating under the conditions for which it is designed, the oil-bath cleaner is highly efficient

(NOTE: It is not always operating under designed conditions, so the efficiency may be lower at times when the air flow drops below its rated capacity.)

B. Dry (paper-filter) type (Transparency 2)

1. Depends on a special paper to filter out dirt particles
2. Dry-type cleaner normally needs servicing every 50 hours
3. Built for two-stage cleaning
 - a. Pre-cleaning
 - b. Filtering

II. Advantages of a dry-type air cleaner over an oil-bath cleaner

- A. Easier to service
- B. Requires less frequent servicing
- C. Fuzz and chaff cause less restriction to air passage
- D. Less messy
- E. More efficient at a wide range of conditions
- F. Neglect of air-cleaner servicing does not harm the engine as long as there is no hole in the filter or a loose fitting where dirt can get through

(NOTE: However excess fuel consumption may cause washing of cylinders, therefore, excess wear.)

III. Importance of proper air-cleaner maintenance

- A. Dirt, which enters the intake manifold of an engine and passes into the engine cylinders, mixes with the oil on the cylinder walls to form a grinding compound

- B. Tractors operating under dusty conditions without an air filter have been known to wear so rapidly they require a major overhaul after operating fifteen hours or less

(NOTE: (Manufacturers have made every effort to equip tractors with the most efficient air cleaner available so the owner will get the longest possible usage before an overhaul is necessary.)

IV. Difference in dry-type cleaner found in tractors and those in automobiles

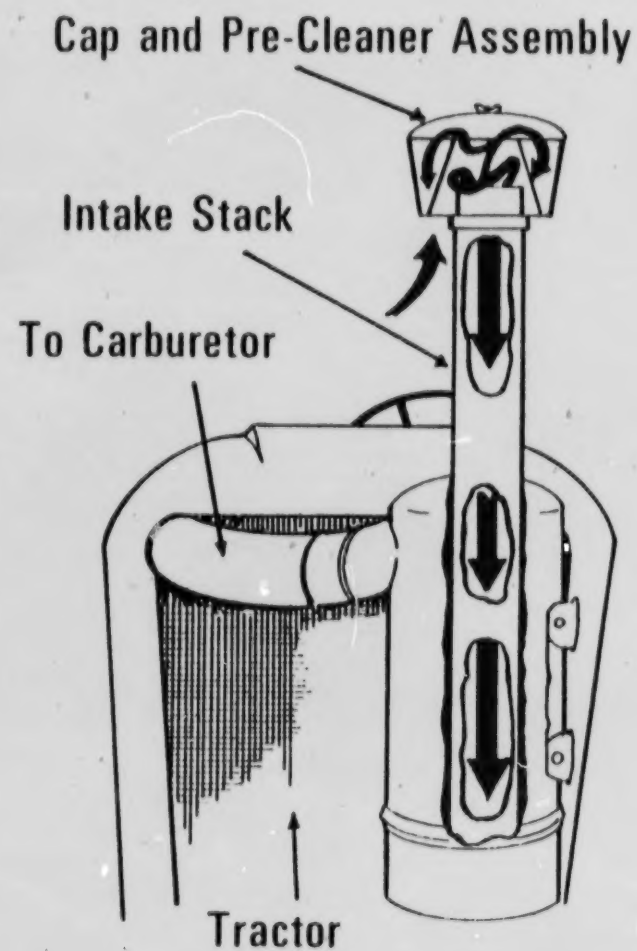
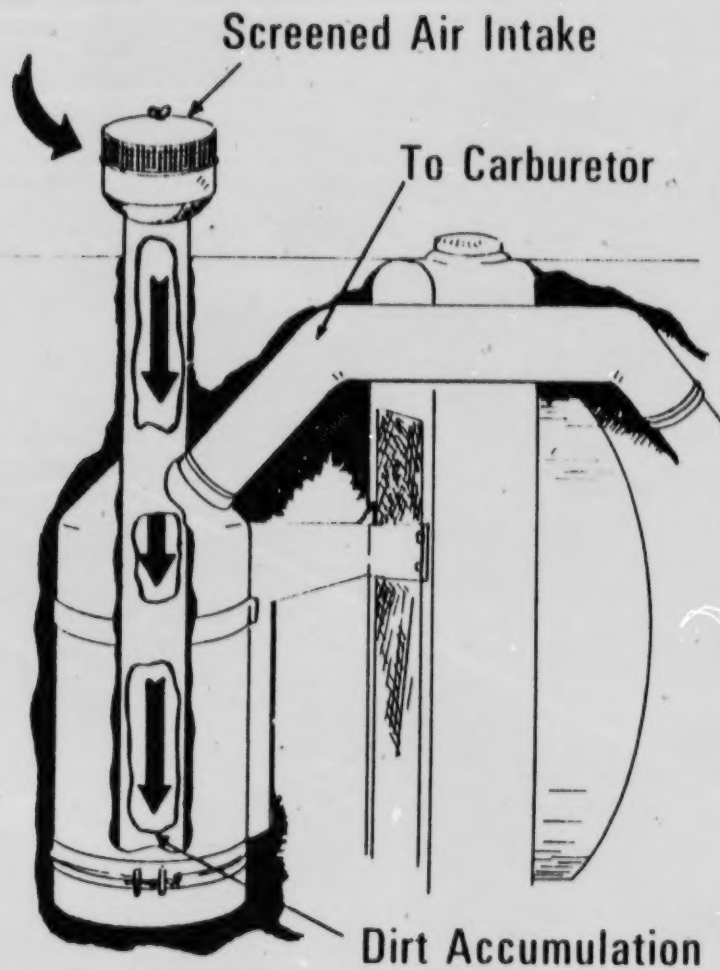
- A. Tractor cleaner is equipped with a pre-cleaner for removing large particles of dirt
- B. The tractor cleaner has a filter element that is larger for the same horsepower engine
- C. The tractor cleaner has a filter element that is much more ruggedly built to withstand vibration and high engine suction when clogged with dirt

(NOTE: Dust bowl should be cleaned daily or whenever dust deposit is over manufacturers recommendations. Also, automatic dust unloader should be checked out daily to see if it is functional.)

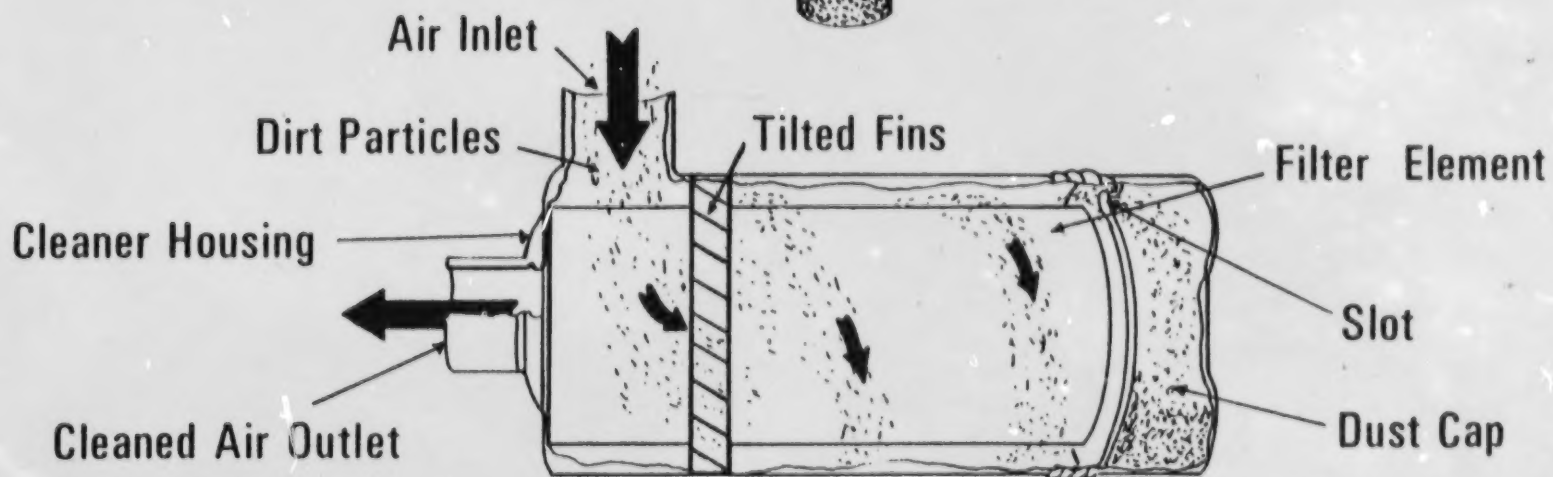
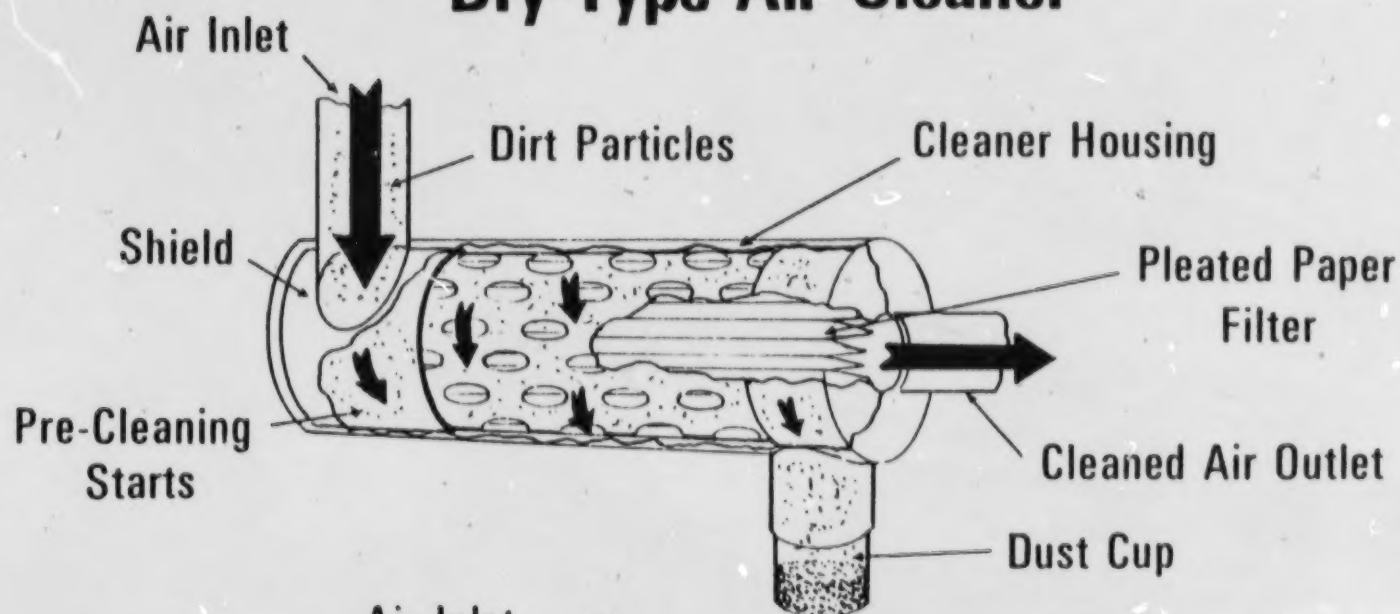
V. Methods of cleaning the filter element

- A. Tapping to loosen dust so it can be shaken out
- B. Use of compressed air
- C. Washing with water and a detergent

Oil-Bath Air Cleaner



Dry-Type Air Cleaner



SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

JOB SHEET #1 - Removing the Dry-Type Air Cleaner

I. Tools and materials needed

- A. Compressed air not to exceed 100 pounds per square inch of pressure
- B. Bucket of warm water with a nonsudsing detergent
- C. Water under pressure at not more than 40 pounds per square inch

II. Procedure

- A. Stop engine if it is running
- B. Squeeze dust unloader if supplied on the air cleaner
(NOTE: Some tractors are equipped with a connection to the engine exhaust system which will automatically unload the dirt from the pre-cleaner.)
- C. Remove hood or grill, if necessary, to provide access to air cleaner unit
- D. Wipe off dust accumulated around end of cleaner where element will be removed
- E. Loosen hand screw or clamp that holds the end cap on the end of the cleaner and remove cap
- F. Clean the area around the element and clean the dust cap and baffle on air cleaners having end cups
(NOTE: Use a dry cloth. Do not use gasoline, fuel oil, or solvents.)
- G. Check condition of rubber gasket on end of filter element
(NOTE: If the gasket is damaged or missing, replace the filter element with a new one. Do not bother to clean it. If reinstalled, uncleaned air will pass directly from the pre-cleaner into the engine and cause rapid wear.)

SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

JOB SHEET #2 - Cleaning the Dry-Type Air Cleaner

I. Tools and materials needed

- A. Compressed air not to exceed 100 pounds per square inch of pressure
- B. Bucket of warm water with a nonsudsing detergent
- C. Water under pressure at not more than 40 pounds per square inch

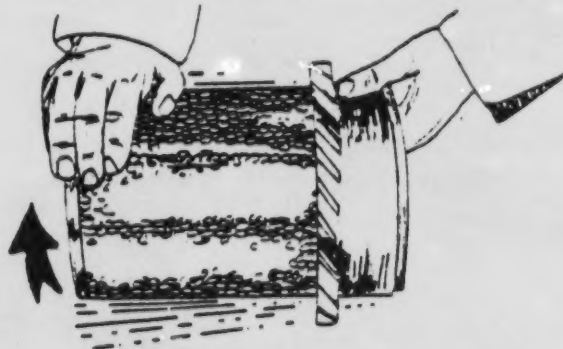
II. Procedure

A. To clean the filter element by tapping, proceed as follows

- 1. Tap filter element to loosen dirt, but gently enough that element is not damaged (Figure 1)

(NOTE: You may tap the element carefully against the palm of your hand.)

FIGURE 1



- 2. Rotate element during tapping procedure and shake out dust

B. To clean the filter element with compressed air, proceed as follows

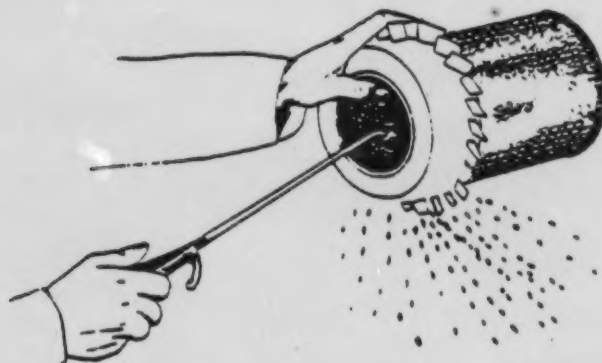
- 1. Direct air from air nozzle against inside of filter element

(NOTE: Hold the air nozzle about an inch away from the inner screen of the element. Directing the air from the center to the outside--opposite normal air flow--loosens the outside dirt and opens the small passageways in the paper filter. Blowing air from the outside to the center tends to compact the dirt in the small openings in the paper filter.)

It is helpful if the air nozzle is equipped with a deflector to spread the air to avoid blowing a hole in the filter element.

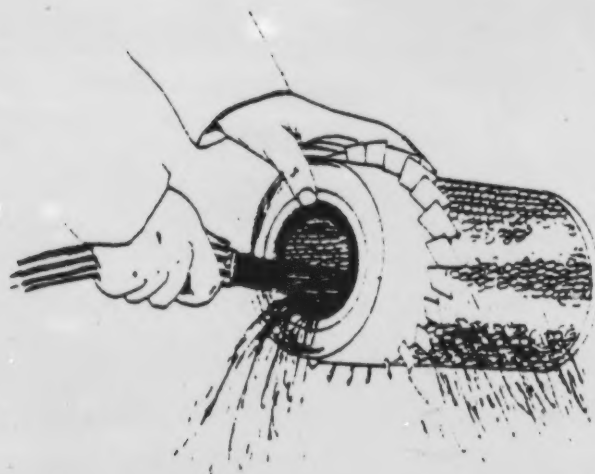
The air must be dry and pressure at the nozzle not exceed 100 pounds per square inch. (Figure 2)

FIGURE 2



2. Continue blowing and rotating the element until it is clean
- C. To clean the filter element by washing, proceed as follows
1. Clean away as much dirt as possible with clean water from a hose or use compressed air (Figure 3)

FIGURE 3



2. Wash element in warm water and detergent (Figure 4)

(NOTE: Use a nonsudsing detergent. Do not use fuel oil, gasoline or other petroleum solvents.)

FIGURE 4



3. Rinse the element

(NOTE: Use clean water as shown then shake excess water from element.)

4. Allow element time to dry

(NOTE: Allow approximately 24 hours at 70 degrees for the drying time. Be sure you do not leave the wet element where it will be exposed to freezing weather.

Do not use compressed air or engine air flow to dry the filter element. It will probably rupture the paper filter. Do not oven dry.)

5. Inspect element for damage--If there is slight rupture in the paper element, throw it away

6. To install the filter element, proceed as follows

- a. Replace the filter element in the cleaner; be certain engine is not running when the element is replaced
- b. Tighten wing nut (with fingers only) that holds element in place
- c. Complete remaining procedures in reverse order from those used to remove the filter element

SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

JOB SHEET #3 - Servicing the Oil-Bath Air Cleaner

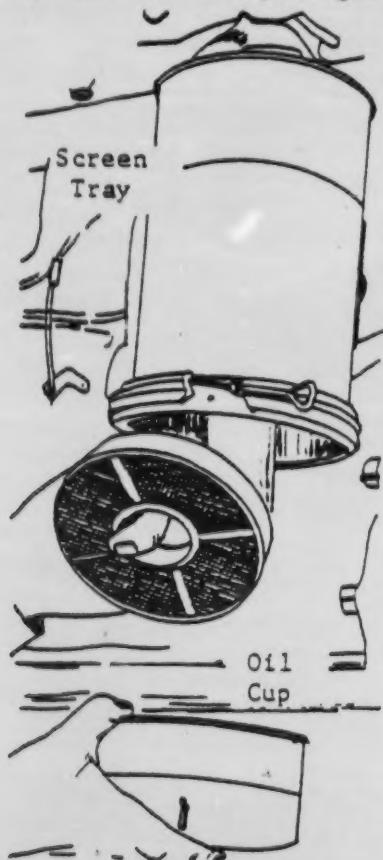
I. Tools and materials needed

- A. Cleaning rags
- B. Large container of cleaning solvent (kerosene or diesel fuel)
- C. Set of open-end wrenches
- D. Screwdriver
- E. Pliers
- F. Stick about three feet long
- G. Cup or pitcher

II. Procedure

- A. Remove oil cup and screen tray (Figure 1)

FIGURE 1

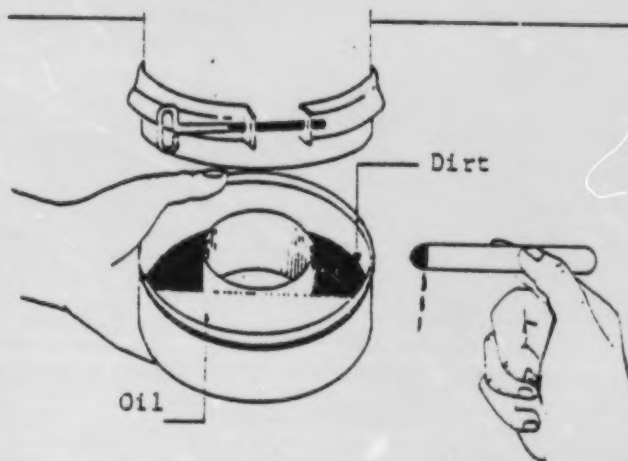


(NOTE: Some air cleaners have no screen tray.)

- B. Check depth of sediment deposit in outer chamber (Figure 2)

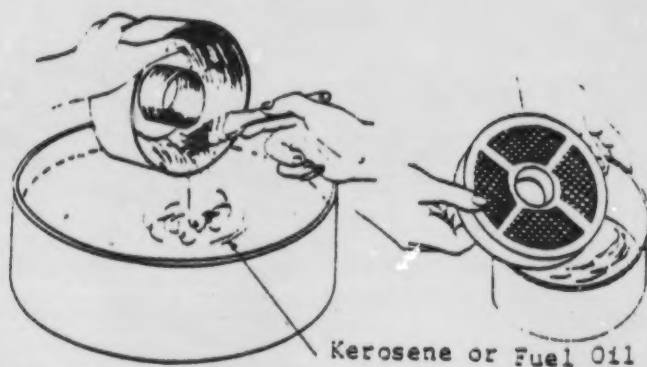
(NOTE: If sediment in the outer compartment is more than 1/2 inch in depth, proceed with cleaning the cup. If the oil has thickened even though the dirt depth may not be 1/2 inch, change the oil.)

FIGURE 2



- C. If cup needs cleaning, throw away dirty oil, scrape, then wash inner and outer cups with clean kerosene, mineral spirits, or diesel fuel (Figure 3)

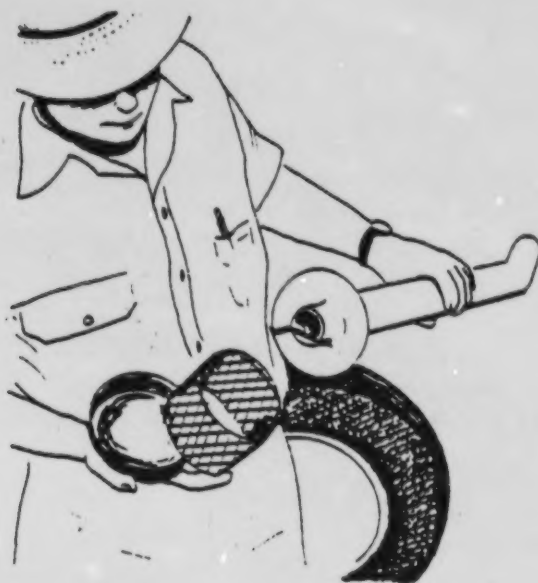
FIGURE 3



D. Inspect center tube and lower filter element

(NOTE: If both the center tube and lower filter appear dirty, remove the complete filter body for adequate cleaning. If tractor has a vertical stack with a pre-cleaner on top, remove that assembly first.) (Figure 4)

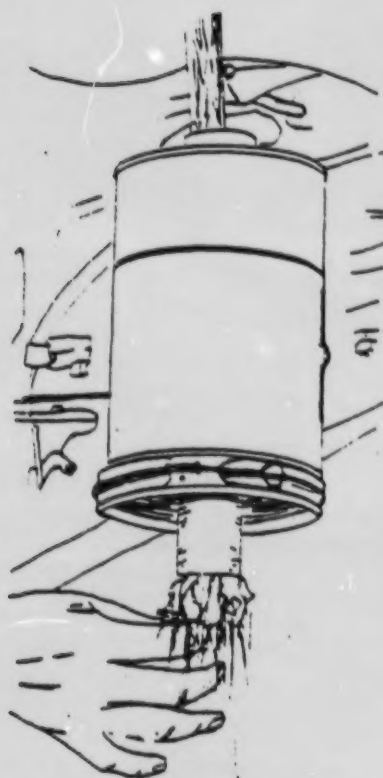
FIGURE 4



E. Remove dirt from center tube (Figure 5)

(NOTE: Use a lintless cloth soaked with diesel fuel or kerosene and push it through the center tube with a stick. Some center tubes are smaller at the lower end so be careful not to damage the tube.)

FIGURE 5



F. Clean dirt from lower filter

(NOTE: On many filters there is an upper and lower filter (separation screen) that makes up the filter element. On most elements the lower filter can be removed. If the filtering element is held in place by spot welding or other means, flush the cleaning solvent through the mesh as shown in figure below.)

FIGURE 6



G. Clean shell and upper metal-wood filter

(NOTE: Soak the entire assembly in kerosene or fuel oil, then flush with clean solvent to remove the loosened oil and dust or manufacturer recommendations.)

H. Drain filter body and screen for several minutes

(NOTE: Do not use gasoline for cleaning.)

I. Clean the screened air intake cap or pre-cleaner

J. Check hose connections

K. Refill cup with oil to "oil level" mark

(NOTE: Most operator's manuals recommend the same weight oil as used in the engine crankcase.)

L. Reassemble filter parts

(NOTE: Be sure all connections are tight and any worn or damaged hoses or gaskets replaced. If there is any place where uncleaned air can enter the air ducts, particularly after the air has passed through the cleaner, dirt and grit will enter and greatly increase tractor wear.)

SERVICING THE TRACTOR—AIR SUPPLY SYSTEM
UNIT IV

TEST

1. Place an "O" by the characteristics that apply to an oil-bath type air cleaner and "D" by the characteristics that apply to a dry-type air cleaner.
 - ☐ a. Normally needs servicing every 50 hours
 - ☐ b. Depends on washing the air free of dust particles by pulling it through a bath of oil
 - ☐ c. Depends on a special paper to filter out dirt particles
 - ☐ d. Should be serviced daily
2. Name three advantages of a dry-type air cleaner over an oil-bath cleaner.
 - a.
 - b.
 - c.
3. Discuss in writing why proper air-cleaner maintenance is important.
4. Select from the list below the differences between dry-type air cleaners found in tractors and those found in automobiles. Place an "X" by the statements that are correct.
 - ☐ a. Tractor cleaner is equipped with a pre-cleaner for removing large particles of dirt
 - ☐ b. The automobile cleaner has a filter element that is larger for the same horsepower engine
 - ☐ c. The tractor cleaner has a filter element that is much more ruggedly built to withstand vibration and high engine suction when clogged with dirt

5. List three methods of cleaning the filter element.

a.

b.

c.

6. Demonstrate the ability to:

a. Remove and clean the dry-type air cleaner

b. Disassemble and service the oil-bath air cleaner

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

SERVICING THE TRACTOR--AIR SUPPLY SYSTEM
UNIT IV

ANSWERS TO TEST

1. a. D
b. O
c. D
d. O
2. Any three of the following:
 - a. Easier to service
 - b. Requires less frequent servicing
 - c. Fuzz and chaff cause less restriction to air passage
 - d. Less messy
 - e. More efficient at a wide range of conditions
 - f. Neglect of air cleaner servicing does not harm the engine as long as there is no hole in the filter or a loose fitting where dirt can get through
3. a. Dirt, which enters the intake manifold of an engine and passes into the engine cylinders, mixes with the oil on the cylinder walls to form a grinding compound
b. Tractors operating under dusty conditions without an air filter have been known to wear so rapidly they required a major overhaul after operating fifteen hours or less
4. a
c
5. a. Tapping to loosen dust so it can be shaken out
b. Use of compressed air
c. Washing with water and a detergent
6. Performance skills will be evaluated to the satisfaction of the instructor.

HYDRAULICS
UNIT XVII

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to service and do minor repair on common hydraulic systems of farm tractors. He should be able to understand the basic principles of hydraulics. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write a short paragraph including Pascal's Law to explain the basic principles of hydraulics.
2. Sketch, label, and define the function of the 5 basic parts of a simple hydraulic system.
3. Identify 3 kinds of hydraulic pumps.
4. Identify 2 kinds of common types of hydraulic systems.
5. Label the parts of a single action cylinder.
6. Label the parts of a double action cylinder.
7. Describe the specifications of the two standard sizes of remote cylinders.
8. List 3 major reasons for system breakdown.
9. Match hydraulic system failures with probable causes.
10. Name three contaminants of hydraulic fluid.
11. Identify the 3 common types of reuseable hose connections.
12. Distinguish between a high pressure hose and a low pressure hose.
13. Explain in a short paragraph how to determine what type of hydraulic fluid or oil to use in a specific hydraulic system.
14. List 3 signs of problems in hydraulic systems.
15. Demonstrate the replacement of the filter on a typical hydraulic system.
16. List the steps in daily service of a specific hydraulic system.

HYDRAULICS
UNIT XVII

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet
- B. Provide students with information sheet
- C. Make transparencies
- D. Discuss objectives
- E. Discuss information sheets
- F. Collect samples of hoses, cylinder, pumps, etc. for demonstration
- G. Arrange field trip to study hydraulic repair and service equipment
- H. Give test

II. Students:

- A. Read objective sheet
- B. Study information sheets
- C. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
 - 1. TM 1 - Basic Principle of Hydraulics
 - 2. TM 2 - Basic Parts of Hydraulic System
 - 3. TM 3 - Three types of Hydraulic Valves
 - 4. TM 4 - Three Common Types of Hydraulic Pumps
 - 5. TM 5 - Two types of Hydraulic Systems
 - 6. TM 6 - Single Action and Double Action Cylinder
 - 7. TM 7 - Features of Standard Remote Cylinders
 - 8. TM 8 - Three types of Reuseable Hose Fittings
- D. Test
- E. Answers to test

II. References:

- A. Teaching Kit - Hydraulics, available from Standard Oil Division of American Oil Company. Very good material includes:
 - a. student booklets, teachers booklet, pre-tests, post test, learning activities, and transparency masters. Cost about \$8.00
- B. Tractor Hydraulics, AAUM, Coordinators Office, Agriculture Engineering Office, Athens, Georgia.
- C. Hydraulic Power Transmission, Standard Oil, Division of America Oil Company, Kansas City, Missouri.
- D. FOS - Fundamentals of Service - Hydraulics, available through your local John Deere Dealer.
- E. Tractor Maintenance AAUM, Coordinator's Office, Agriculture Engineering Building, Athens, Georgia.
- F. Tractor Repair and Maintenance, Department of Agriculture Education University of Nebraska,

HYDRAULICS
UNIT XVII

INFORMATION SHEET

- I. The basic principle of hydraulics as stated by Pascal in the seventeenth century is: Pressure applied at any point in a static fluid is the same in all directions and acts with equal force in all directions.
(Transparency 1)
- (NOTE: If the large piston in TM 1 is 3 times larger than the small piston - the force exerted by the small piston can be 3 times the large piston. However, the distance traveled by the large piston will be $\frac{1}{3}$ that of the small piston.)
- II. The five basic parts of a simple hydraulic system and their functions are: (Transparency 2)
- A. pump - to move fluid within the system
 - B. valves - control the pressure direction and volume of flow
 - C. reservoir - hold excess oil, maintain oil level above the section line opening, allowing air and foreign matter to separate from the oil and dissipate heat during normal operation.
 - D. cylinder - convert fluid power to mechanical power-piston cylinder gives straight power vane cylinders give rotary power
 - E. lines or piping - transport fluid within the system
- III. Terms and definitions
- A. Pump - a device that converts mechanical force to fluid power.
 - B. Valve - controls direction, pressure, or volume of flow. There are three common types (Transparency 3)
 - C. Reservoir - hold excess oil maintains oil level above the suction line opening, allows air and foreign matter to separate from the oil and dissipates heat during normal operation.
 - D. Cylinder - converts fluid power to mechanical power
 - E. Line or piping - carries fluid within the system
 - F. Relief valve - used to limit or maintain pressure in a system
 - G. Volume control valve - limits or increases the volume of fluid to or from a hydraulic cylinder or motor.
 - H. Pressure control valve - limits or maintains pressure within the system
 - I. Directional flow valve - controls the direction of flow to and from an activator
 - J. External leakage - loss of fluids out of the system
 - K. Internal leakage - leakage past seals inside the system. I.E. pistons, valves, pumps.

- L. Drain schedule - periodic draining of the system as recommended by the manufacturer.
- M. Flow - the movement of fluid through the system
- N. Filter - device for removing foreign material from fluid
- O. Fluid - the oil used to transmit force within the system
- P. Bleed - removal of air from the system
- Q. Single action cylinder - force is applied in only one direction
- R. Double action cylinder - force is applied in two directions
- S. Low pressure hose - used in applications where pressure on 1" hose will generally not exceed 800 psi.
- T. Medium pressure hose - used in applications where pressure on 1" hose will not exceed 1875 psi
- U. High pressure hose - used in applications where pressure on 1" hose will not exceed 3000 psi.
- V. Permanent hose fitting - hose and fittings that are crimped or swaged together and usually discarded when replacement is necessary
- W. Reuseable hose fittings - fittings are usually screwed or clamped on and when the hose wears out the fittings can be reused.
- X. Quick couplers - are used to connect oil lines that are disconnected frequently.
- Y. Seals - used to prevent oil from escaping from chambers within the system and out of the system.
- Z. Hydraulic motor - a type of cylinder used to convert fluid power to rotary power.
- AA. Open center system - the pump runs all the time even if pressure is not needed.
- BB. Closed center system - the pump "takes a break" during neutral.
- CC. Remote cylinder - a hydraulic cylinder mounted away from the supply source

IV. The three common kinds of hydraulic pumps used in agriculture are:
(Transparency 4)

- A. Gear - the pack horse of hydraulic systems. Widely used because they are simple and economical. Two types of gear pumps are:
 - (a) external
 - (b) internal
- B. Vane - a versatile pump and can be used in single, double, or triple units
- C. Piston - are favored by modern systems that require high speeds and high pressures. One disadvantage is that they are complex and more expensive than vane or gear pumps.

V. The two common types of hydraulic systems are: (Transparency 5)

- A. Open center system - the pump runs constantly, even if in neutral. There is a continuous flow of oil from the reservoir to the pump, to the control valve, and back to the reservoir. In neutral, oil flows through the control valve and back to the reservoir.
- B. Closed center system - the pump "takes a break" during neutral. The control valve stops (deadends). The flow of oil from the pump the closed center feature. This causes the pump to stop pumping oil (shut off by a pressure regulating valve.) However, if the pressure of the oil drops below full system pressure during neutral, the pump starts pumping again long enough to build up the pressure.

VI. The parts of a single action cylinder are: (Transparency 6)

- A. Mount
- B. Oil inlet
- C. Piston
- D. Piston seal
- E. Piston rod
- F. Air vent
- G. Rod wiper seal
- H. Cylinder housing

VII. The parts of a double action cylinder are: (Transparency 6)

- A. Mount
- B. Oil port
- C. Piston seals
- D. Piston
- E. Oil port
- F. Removable end
- G. Piston rod
- H. Rod seal
- I. Cylinder housing

VIII. The two standard sizes of remote hydraulic cylinders are: (Transparency 7)

- A. Normal application
 - 1. 1" mounting pin
 - 2. 8" stroke
- B. Heavy duty applications on tractors with more than 80 HP
 - 1. 1" mounting pin
 - 2. 8" stroke
 - 3. More than 18,000 lbs. of thrust

IX. Reasons for breakdown of a hydraulic system

- A. Dirty oil
- B. Improper type of oil
- C. Water in oil

X. Hydraulic System Failures

- A. Pumps make excessive noise

Probable Causes of Failure

- 1. Air leaking into system
- 2. Loose or worn parts
- 3. Sticking vane in pump
- 4. Pump running in excess of rated speed
- 5. Oil of too high viscosity or too high pour point
- 6. Plugged reservoir vent
- 7. Plugged or restricted intake line or filter
- 8. Pump misaligned with motor

- B. Hydraulic System Overheats

- 1. Oil viscosity too high
- 2. Relief valve set too high
- 3. Excessive friction
- 4. Oil cooler inoperative
- 5. Pump discharge not unloading properly
- 6. Restricted or undersized valves or hydraulic lines

- C. Erratic action of cylinders

- 1. Valves sticking or binding
- 2. Cylinder sticking or binding
- 3. Air in system
- 4. Sluggish during warmup
- 5. Internal leakage in cylinder or valves
- 6. Pilot control pressure too low

XI. The three contaminants of hydraulics fluid are:

- A. Dust or dirt
- B. Water
- C. Air

XII. Common types of reuseable hose connections (Transparency 8)

- A. Socketless - Low pressure
- B. Socket and Nipple - Medium pressure
- C. Socket and Nipple - High pressure

XIII.

- A. A high pressure hose will generally have at least 1 and up to 3 layers of metal braided reinforcement
- B. Low pressure hose will usually have only 1 layer of braided fabrics or steel reinforcement

XIV. For any piece of equipment the manufacturer will provide an operator's and/or service manual which should specify the type of fluid to be used in the system. The operator should become familiar with the requirements and not make any changes.

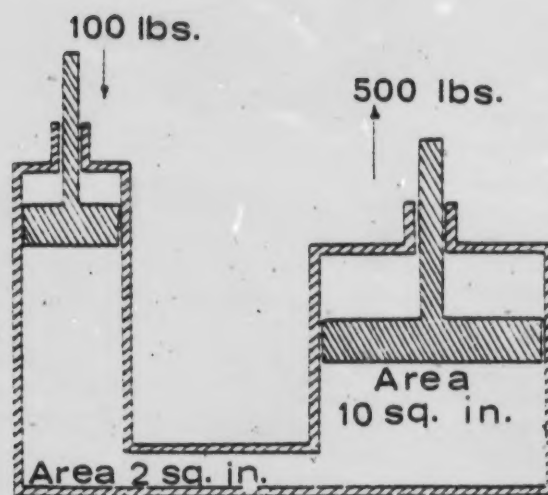
XV. Signs of problems in a hydraulic system are:

- A. Excessive pump noise
- B. Excessive wear of moving parts
- C. System overheating
- D. Fluid leaks (external)
- E. Internal leakage as evidenced by cylinder movement when controls are in stationary position
- F. Pump does not deliver oil
- G. Fluid level low
- H. Erratic action of cylinders

XVI. Replacement of filter on typical hydraulic system

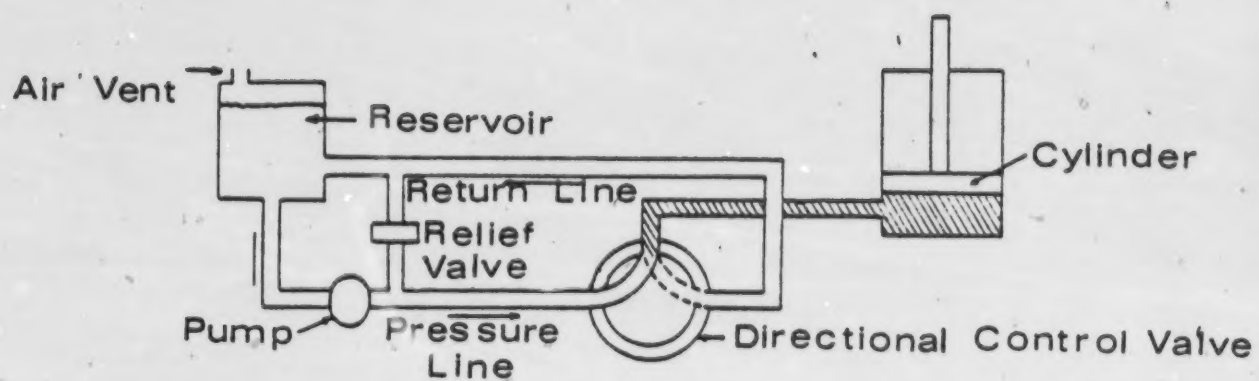
- A. Refer to operators' and/or service manual for proper replacement filter.
- B. Procure new filter element.
- C. Clean area around filter housing
- D. Remove old filter
- E. Check old filter for any obvious contaminants such as steel cuttings, brass cuttings, dirt, lint, rubber, etc.
- F. Install new filter and seal on filter compartment
- G. Start up system and check filter cartridge for leaks

Basic Principle of Hydraulics



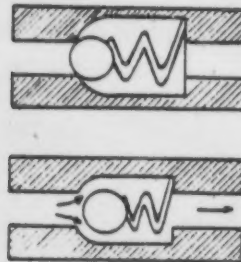
TM 1

Basic Parts of Hydraulic System

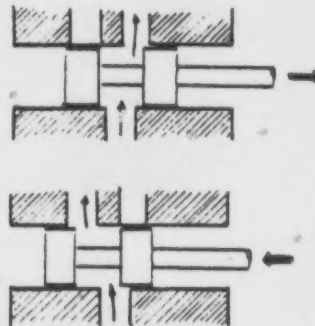


Three Types of Valves

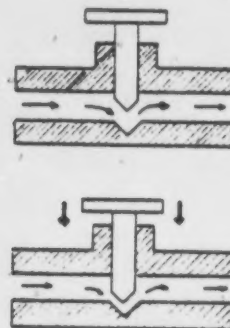
Pressure
Control



Directional
Control

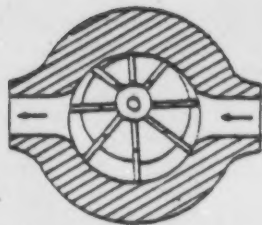


Volume
Control

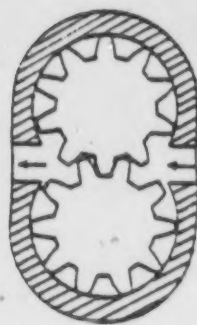


Three Common Types of Hydraulic Pumps

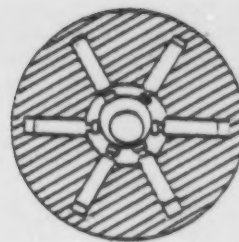
Vane



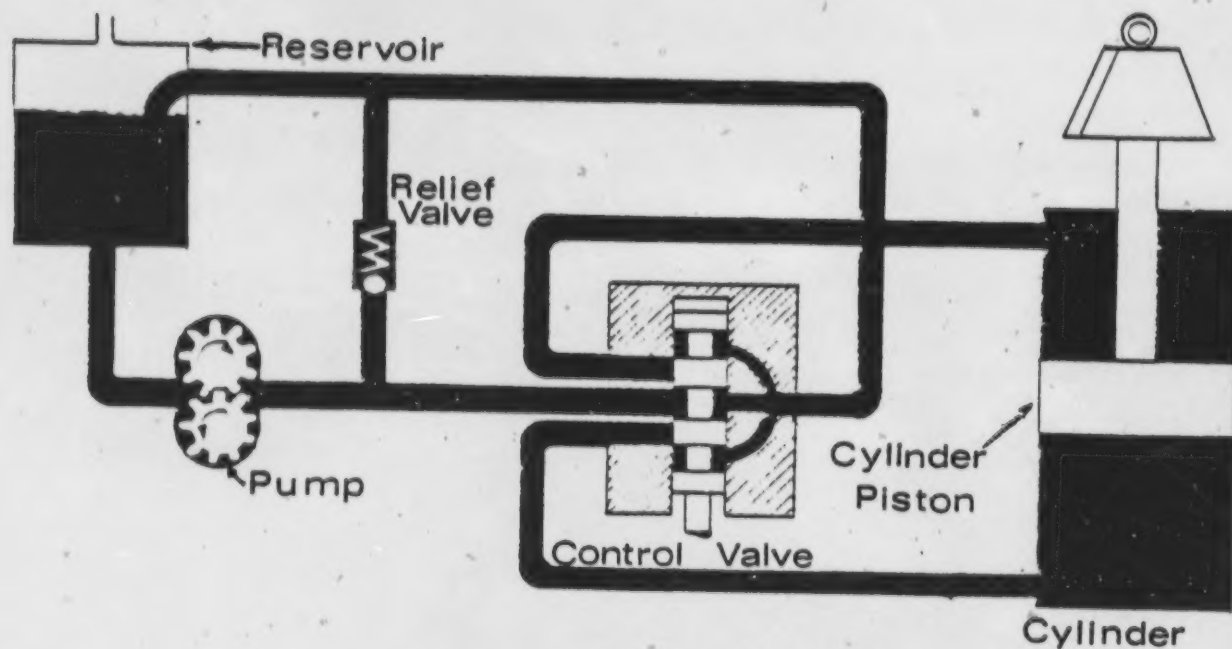
Gear



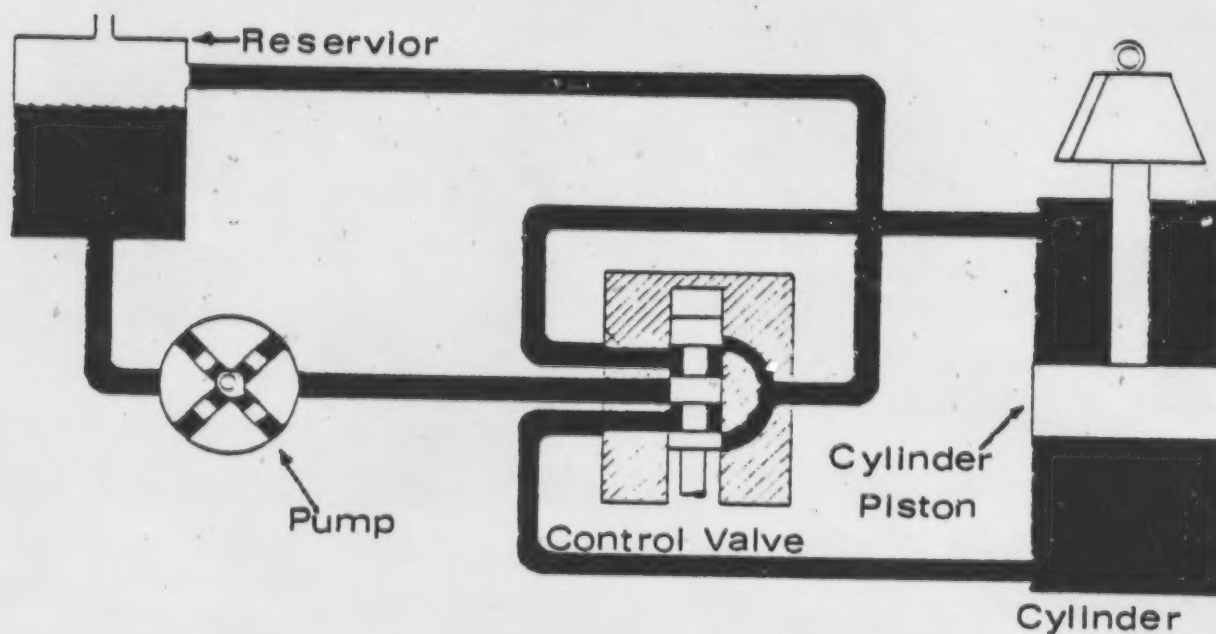
Piston



TWO COMMON HYDRAULIC SYSTEMS

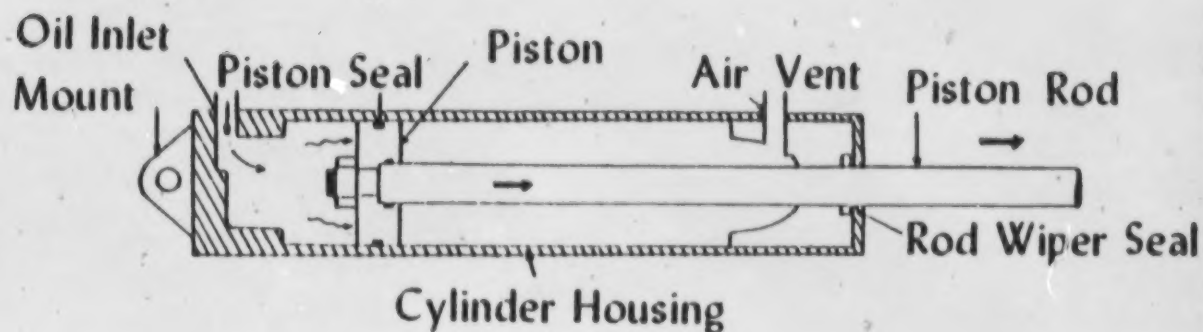


OPEN CENTER SYSTEM

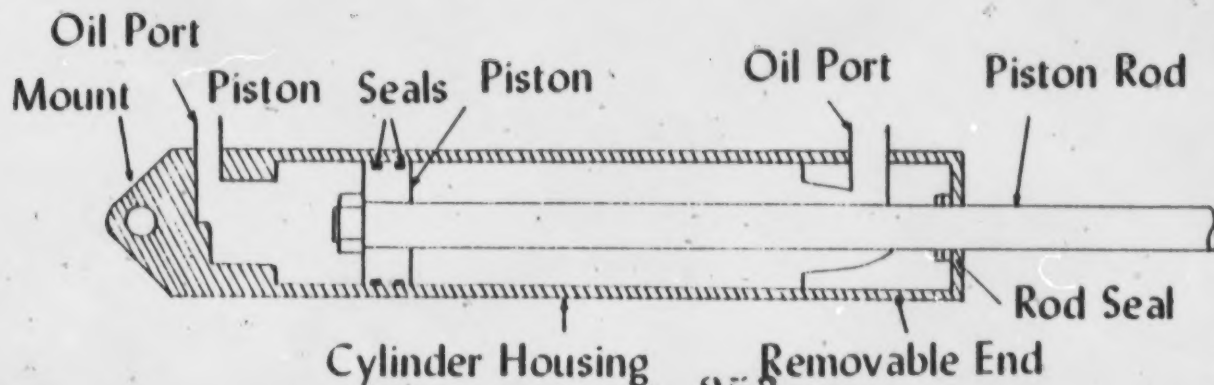


CLOSED CENTER SYSTEM

A Typical Single-Acting Cylinder



A Typical Double-Acting Cylinder

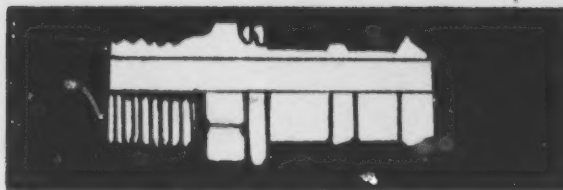


We have standardized features

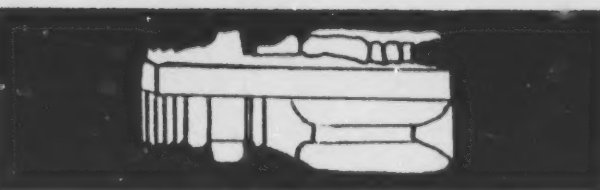


1 - 1 inch mounting pins
2 - 8 inch stroke

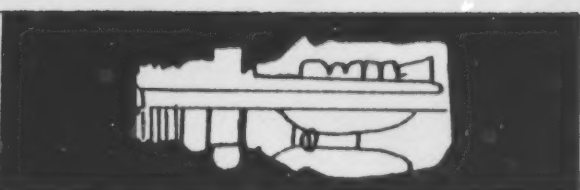
You can change cylinders between implements!



SOCKETLESS
(Low Pressure)



SOCKET AND NIPPLE
(Medium Pressure,
Single Wire Braid Hose)



SOCKET AND NIPPLE
(High Pressure - Notch on Socket)
(Multiple Wire Braid Hose)

HYDRAULICS

TEST

1. Write a short paragraph using Pascal's law and explain the basic principle of hydraulics.

2. Sketch and label a simple hydraulic system to show the 5 basic parts.

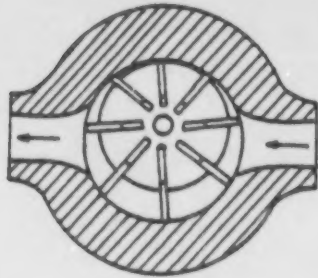
3. Match the following terms to the proper definition;

- | | |
|-------------------------------|---|
| ___ a. pump | 1. hydraulic cylinder mounted away from the supply source. |
| ___ b. valve | 2. type of cylinder used to convert fluid power to rotary power. |
| ___ c. reservoir | 3. the pump runs all the time even if the pressure is not needed |
| ___ d. cylinder | 4. used to prevent oil from escaping from the chambers within the system and out of the system |
| ___ e. line or piping | 5. the pump "takes a break" during neutral |
| ___ f. relief valve | 6. controls the direction pressure or volume of flow |
| ___ g. volume control valve | 7. used to increase or decrease pressure in a system |
| ___ h. pressure control valve | 8. limits or increases the volume of fluid to or from a cylinder |
| ___ i. flow | 9. limits or maintains pressure within the system |
| ___ j. drain schedule | 10. controls the direction of flow to and from an activator |
| ___ k. directional flow valve | 11. loss of fluid out of the system |
| ___ l. external leakage | 12. leakage past seals, valves, pistons, or pumps |
| ___ m. internal leakage | 13. periodic draining of the system as recommended by the manufacturer |
| ___ n. filter | 14. movement of fluid through the system |
| ___ o. fluid | 15. converts mechanical force to fluid power |
| ___ p. bleed | 16. holds excess oil, maintains oil level above the suction line opening, allow air and foreign matter to separate from the oil and dissipates heat during normal operation |
| ___ q. single action cylinder | 17. converts fluid power to mechanical power |
| ___ r. double action cylinder | |
| ___ s. low pressure hose | |
| ___ t. medium pressure hose | |
| ___ u. high pressure hose | |
| ___ v. permanent hose fitting | |
| ___ w. reuseable hose | |
| ___ x. quick couplers | |
| ___ y. seals | |
| ___ z. hydraulic motor | |
| ___ aa. open center | |
| ___ bb. closed center | |
| ___ cc. remote cylinder | |

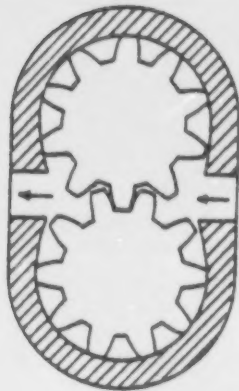
18. carries fluid within the system
19. device for removing foreign material from fluid
20. the oil used to transmit force within the system
21. removal of air from the system
22. force can be applied in only one direction
23. force can be applied in two directions
24. hose used in applications where pressure on a 1" hose will generally not exceed 800 psi.
25. hose used in applications where pressure on a 1" hose will generally not exceed 1875 psi.
26. hose used in applications where pressure on a 1" hose will not exceed 3000 psi.
27. hose and fitting are crimped or swedged together and usually discarded when replacement is necessary.
28. fittings are usually screwed or clamped on and when the hose wears out the fittings can be reused.
29. used to connect oil lines that are disconnected frequently.

4. Identify the three following drawings of common hydraulic pumps.

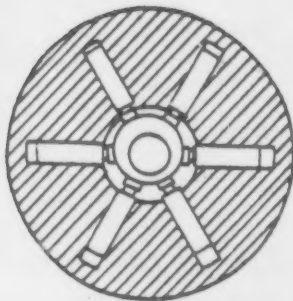
Hydraulic Pumps



a. _____

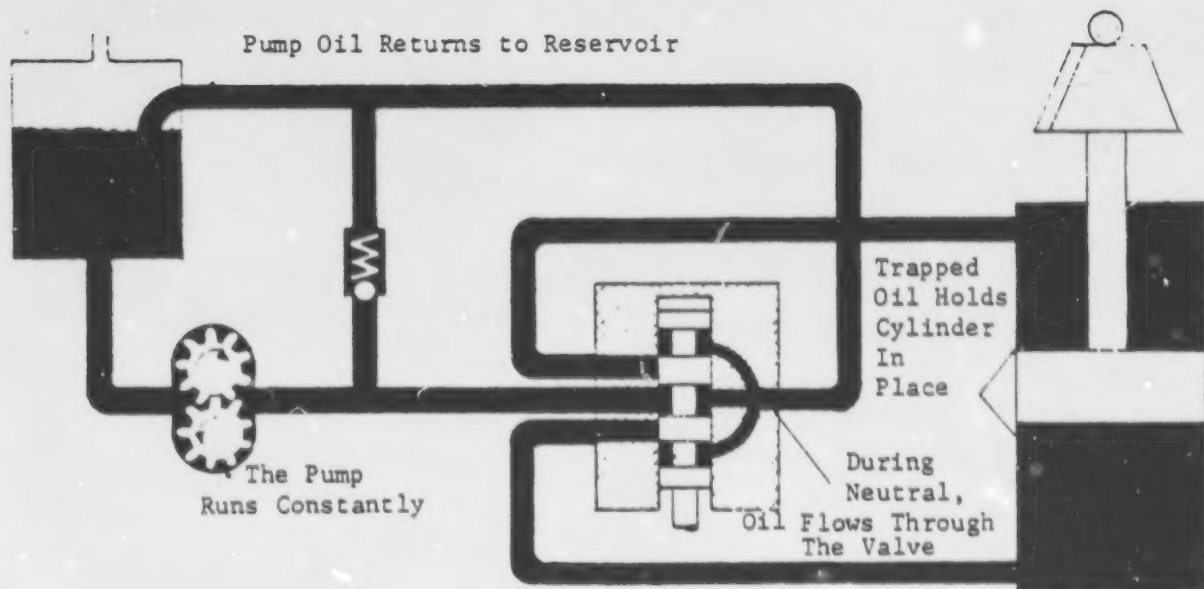


b. _____

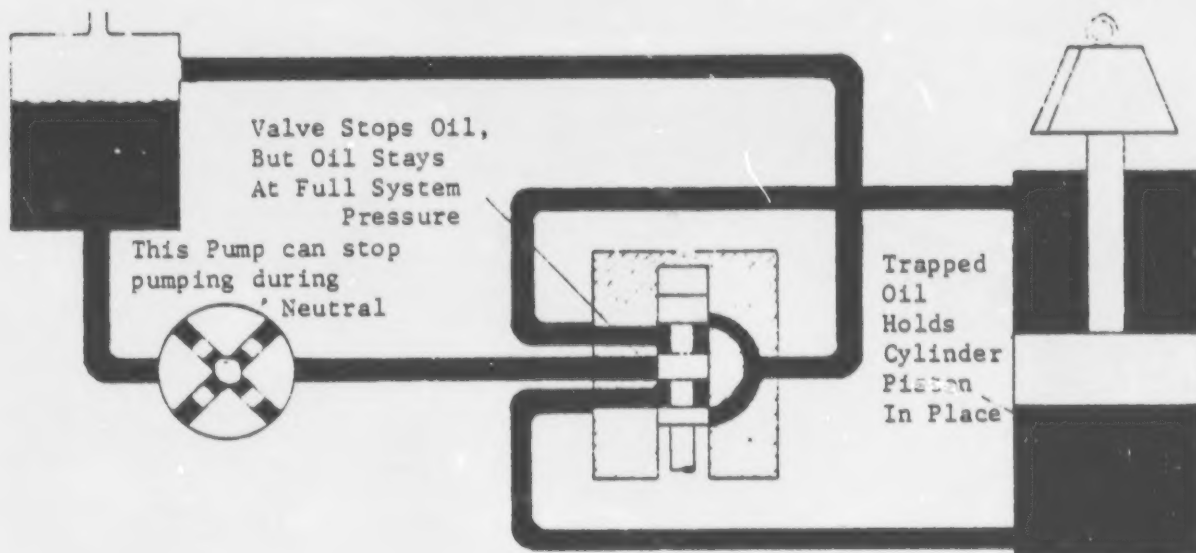


c. _____

5. Identify the following two common hydraulic systems

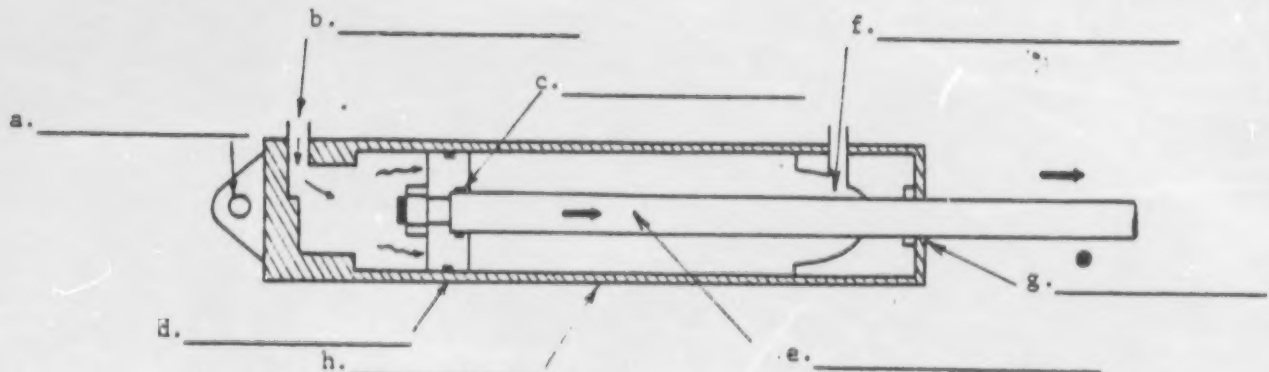


a. _____



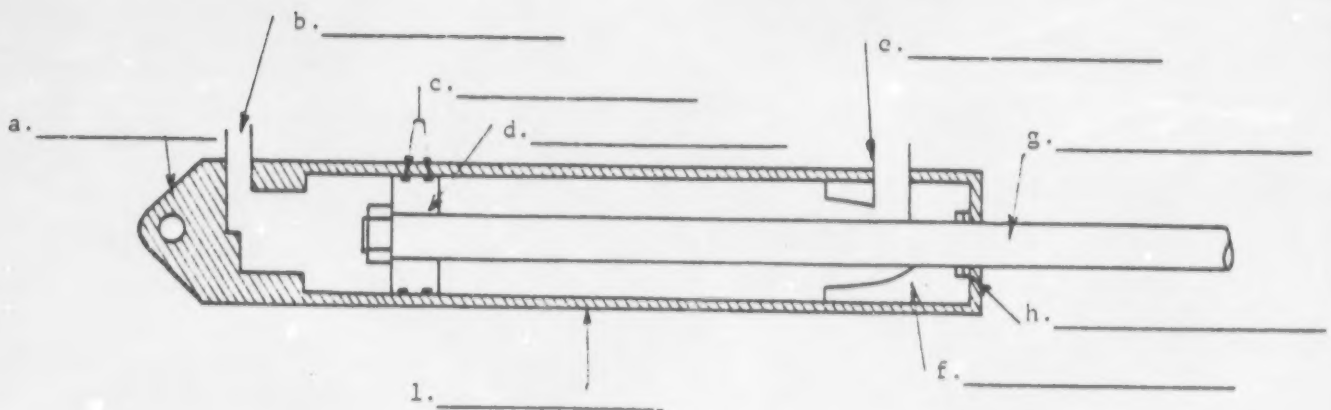
b. _____

6. Label the parts of the following hydraulic cylinder.



A Typical Single-Acting Cylinder

7. Label the parts of the following hydraulic cylinder.



A Typical Double-Acting Cylinder

8. Describe the specifications of the two standard sizes of remote cylinders.

	<u>Small</u>	<u>Large</u>
length of stroke	a. _____	e. _____
diameter of mounting pins	b. _____	f. _____
lbs. of thrust	c. _____	g. _____
size of tractor to be used on	d. _____	h. _____

9. List three major reasons for breakdown of hydraulic systems.

- a. _____
b. _____
c. _____

10. Match the system failures on the left with probable causes on the right.

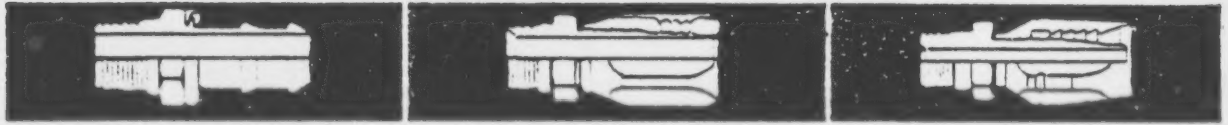
(NOTE: Each failure may have more than one cause. Some failures may have the same causes.)

<u>Problems</u>	<u>Probable Causes</u>
a. Pump makes excessive noise _____	1. Air leaking into system
b. Hydraulic system overheats. _____	2. Relief valve set too high
c. Erratic action of cylinders. _____	3. Pump discharge not unloading properly
	4. Pump running in excess of rated speed
	5. Plugged reservoir vent
	6. Internal leakage
	7. Sluggish during warmup
	8. Valves sticking or binding
	9. Oil too high viscosity
	10. Pump misaligned with motor
	11. Excessive friction
	12. Plugged or restricted intake line
	13. Loose or worn parts, in pump.
	14. Pilot control pressure too high

11. List three contaminants of hydraulic fluid

- a. _____
b. _____
c. _____

12. Identify the three following types of reuseable hose fittings.



a. _____

b. _____

c. _____

13. Using the samples provided by your instructor - identify:

a. Low pressure hose -

b. High pressure hose -

14. Explain in short paragraph how to determine what type of oil or hydraulic fluid to use in a specific hydraulic system.

15. List three signs of problems in a hydraulic system.

a.

b.

c.

16. List the steps in daily service of a specific hydraulic system.

a.

b.

c.

d.

HYDRAULICS
UNIT XVII

ANSWERS TO TEST

1. The basic of hydraulics as stated by Pascal in the seventeenth century is: Pressure applied at any point in a static fluid is the same in all directions and acts with equal force in all directions. (see transparency 1)
2. Sketch should include the following:
pump, reservoir, cylinder, valves, lines or piping
3. Answers to matching quiz

a. 15	h. 7	o. 20	v. 27	cc. 1
b. 6	i. 14	p. 21	w. 28	
c. 16	j. 13	q. 22	x. 29	
d. 17	k. 10	r. 23	y. 4	
e. 18	l. 11	s. 24	z. 2	
f. 9	m. 12.	t. 25	aa. 3	
g. 8	n. 19	u. 26	bb. 5	
4. a. vane
b. gear
c. piston
5. a. open center system
b. closed center system
6. Parts of single action cylinder:

a. mount	e. piston rod
b. oil port	f. air vent
c. piston	g. rid wiper seal
d. seal	h. cylinder housing
7. Parts of double action cylinder:

a. mount	e. removable end
b. oil port	f. piston rod
c. seals	g. rod seal
d. piston	h. cylinder housing
8. Specification of remote cylinders:

a. 8"	e. 16"
b. 1"	f. 1"
c. 6,000 to 12,000	g. 11,000 to 18,000
d. 20 to 80 HP	h. 80 to 200 HP

9. Reasons for breakdown:
 - a. dirty oil
 - b. improper type of oil
 - c. water in oil
10. Match failures and causes
 - a. 1, 3, 4, 8, 9, 10, 12, 13, 14
 - b. 2, 3, 4, 8, 9, 11, 12, 13, 14
 - c. 1, 5, 6, 7, 8, 9, 12, 13
11. Three contaminants:
 - a. dust and dirt
 - b. water
 - c. air
12. Types of hose fittings
 - a. socketless
 - b. socket & nipple
 - c. socket and nipple, notch on socket
13.
 - a. low pressure will only have 1 or less layers of braided reinforcement
 - b. high pressure will have at least 1 and up to 3 layers of steel and/or fabric reinforcement.
14. The manufacturer of every hydraulic system will provide an operator's manual and/or a service manual which will include specification of oil to be used in the system. Also some systems will have a plate or instructions printed on the equipment.
15.
 - a. pump does not deliver oil
 - b. fluid level low
 - c. erratic action of cylinders
16. Steps in daily service:
 - a. check fluid level
 - b. inspect all lines, hoses, cylinders and pump(s) for signs of leakage
 - c. inspect mounts, pins, and mechanical parts for missing parts, signs of wear or breakage.
 - d. operate system on test and listen for any unusual noises, and vibrations.

FASTENERS
UNIT IX

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to define fasteners and identify various types of fasteners. He should be able to match the use of the various types of fasteners and select the most common sizes of nails. He should also be able to name two coatings used on nails and two materials used to manufacture nails. This knowledge will be evidenced by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define fastener.
2. Identify the types of nails.
3. Match the use with the various types of nails.
4. Select from a list the lengths of nails most commonly used.
5. Name two coatings for nails most commonly used.
6. Name two materials used to manufacture nails.
7. Identify five types of screw heads.
8. Identify four types of screws.
9. Select from a list five things to specify when purchasing screws.
10. Identify six types of bolts.
11. Match the use with the various type of bolt.
12. Identify four types of washers.
13. Identify five types of nuts.
14. Identify five types of hinges.
15. Match the use with the various types of hinges.
16. Name two types of glue.

FASTENERS
UNIT IX

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with objective sheet
2. Provide students with information sheet
3. Make transparencies
4. Discuss terminal and specific objectives
5. Discuss information sheet

(NOTE: Instructors may want to secure nail, screw, and bolt charts from the manufacturing companies for display in the shop.)

Students:

1. Read objectives
2. Study information sheet
3. Take test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information sheet
3. Transparency masters
 - TM 1--Types of Nails
 - TM 2--Types of Screws
 - TM 3--Types of Bolts
 - TM 4--Types of Washers
 - TM 5--Types of Nuts
 - TM 6--Types of Hinges
4. Test
5. Answers to test

References:

1. Phipps, Lloyd, J. Mechanics in Agriculture. Danville, Illinois: Interstate Printers and Publishers, Inc. 1967.
2. Jones, Mack M. Shopwork on the Farm. New York: McGraw-Hill Book Co., 1954.

3. Hardware. Indianapolis, Indiana: The National Retail Hardware Association, 1965.
4. Feirer, John L. Woodworking for Industry. Peoria, Illinois: Charles A. Bennett Co., Inc., 1967.

FASTENERS
UNIT IX

INFORMATION SHEET

- I. Fastener--Any device such as a nail, screw, or bolt used to construct or to give stability to an object

- II. Types of nails (Transparency 1)
 - A. Common
 - B. Box
 - C. Finishing
 - D. Flooring
 - E. Shingle
 - F. Roofing
 - G. Plaster board
 - H. Hinge
 - I. Wire staple
 - J. Lead head
 - K. Duplex

- III. Types of nails and their use
 - A. Common--Used for nailing sheeting, shiplap, and fencing
 - B. Box--Used for nailing siding
 - C. Finishing--Used for interior finishing, for ceiling, and for cabinet work
 - D. Flooring--Used in flooring work
 - E. Shingle--Used in nailing shingles
 - F. Roofing--Used in nailing rolled roofing and composition shingles
 - G. Plaster board--Used in nailing plaster board
 - H. Hinge--Used in fastening hinges
 - I. Duplex--Used in form construction
 - J. Wire staple--Used in fence construction
 - K. Lead head--Used in nailing galvanized iron

IV. Lengths of nails

Penny Size	Length In Inches For Common, Box, And Finish
2d	1
3d	1 1/4
4d	1 1/2
4d	1 3/4
*6d	2
7d	2 1/4
*8d	2 1/2
9d	2 3/4
10d	3
12d	3 1/4
*16d	3 1/2
*20d	4
30d	4 1/2
40d	5
50d	5 1/2
60d	6

*Sizes most often used.

(NOTE: A small "d" is used to designate penny.)

V. Coating for nails

- A. Cement
- B. Galvanized

VI. Materials used to manufacture nails

- A. Steel
- B. Aluminum

VII. Types of screw heads

- A. Flat head



- B. Round head



C. Oval head



D. Pan head



E. Hex head



VIII. Types of screws (Transparency 2)

- A. Lag--Used in fastening wood to brick or concrete
- B. Flat head--Used for strength in wood work (usually countersunk)
- C. Oval head--Used in cabinet work and for attaching hinges
- D. Round head--Used for flush mounting
- E. Phillips--Usually used in the auto industry

IX. Specification required when purchasing screws

- A. Amount
- B. Length
- C. Size
- D. Quantity
- E. Type of head
- F. Finish
- G. Use

X. Types of bolts (Transparency 3)

- A. Machine
- B. Carriage
- C. Stove
- D. Plow
- E. Toggle
- F. Expansion

(NOTE: The following are special made bolts designed for a specific purpose.)

- 1. U-bolt
- 2. Eye bolt
- 3. Hook bolt
- 4. Turnbuckle

XI. Types of bolts and their use

- A. Machine--Used in assembling
- B. Carriage--Used in fastening wood and other soft materials
- C. Round head stove--Used in sheet metal work
- D. Flat head stove--Used in sheet metal work
- E. Plow--Used in assembling machinery
- F. Toggle--Used in fastening objects to hollow walls
- G. Expansion--Used in fastening material to concrete walls, floors, etc.

XII. Types of washers (Transparency 4)

- A. Plain (flat)
- B. Lock
 - 1. Common
 - 2. External
 - 3. Internal
 - 4. Internal-External
 - 5. Countersunk

XIII. Types of nuts (Transparency 5)

- A. Square
- B. Hexagon
- C. Cap (Acorn)
- D. Jam or lock
- E. Castle
- F. Wing

XIV. Types of hinges (Transparency 6)

- A. Strap
- B. T
- C. Butt
- D. Screw hook and strap
- E. Cabinet
- F. Hasp

XV. Types of hinges and their use

- A. Strap--Used in heavy construction
- B. T--Used when butt end is fastened into a studding
- C. Butt--Used in cabinet work
- D. Screw hook and strap--Used in hinging gates
- E. Cabinet--Used in cabinet work
- F. Hasp--Used in fastening doors and provides a place for a lock

XVI. Types of glue

- A. Casein (white glue)

(NOTE: Casein is resistant to heat, cold, and moisture, but is not recommended for exterior use.)

- B. Resorcinal resin

(NOTE: Resorcinal resin is recommended for exterior and interior use as it is resistant to exposure to weather.)

Types of Nails

8d Hinge



Plaster Board



Roofing



Shingle



Lead Head

Wire Staple



6d Flooring



6d Finishing



6d Box



6d Common



Duplex

TYPES OF SCREWS ACCORDING TO HEAD SHAPE AND DRIVE

FLAT HEAD
Slotted



FLAT HEAD
Phillips



ROUND HEAD
Slotted



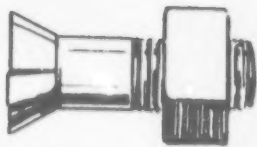
OVAL HEAD
Slotted



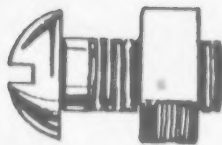
LAG



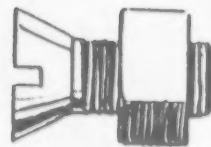
Types of Bolts



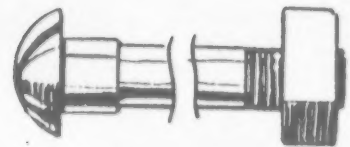
Plow



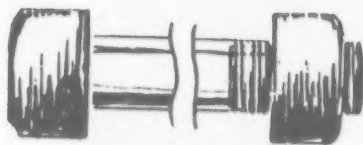
**Round
Head Stove**



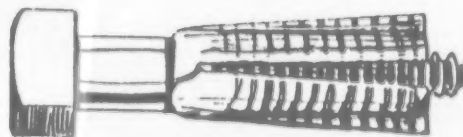
Flat Head Stove



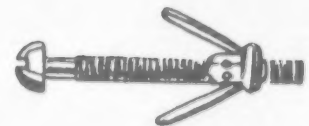
Carriage



Machine



Expansion



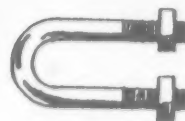
Toggle



Eye Bolt



Hook Bolt



U Bolt



Turnbuckle

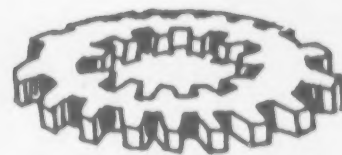
Types of Washers



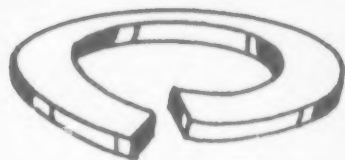
Plain Flat Washer



**Lock Washer
External**



**Lock Washer
Internal-External**



**Common
Lock Washer**

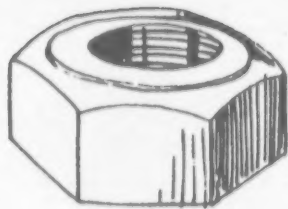


**Lock Washer
Internal**

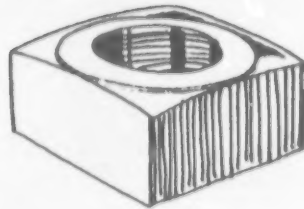


**Lock Washer
Countersunk**

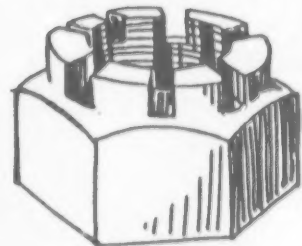
Types of Nuts



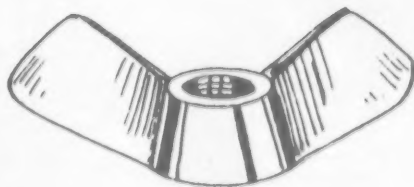
Hexagon



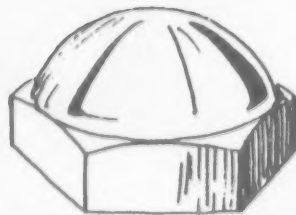
Square



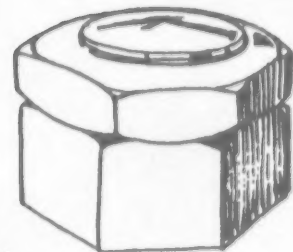
Castle Nut



Wing Nut

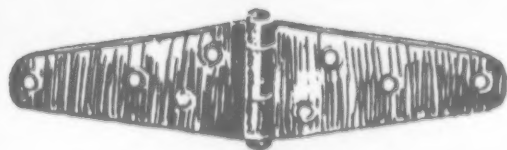


Acorn or Cap Nut

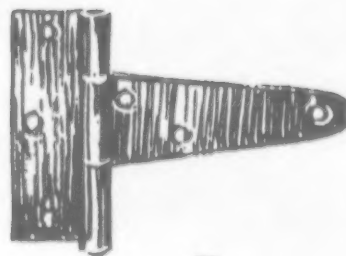


**Jam or
Lock Nut**

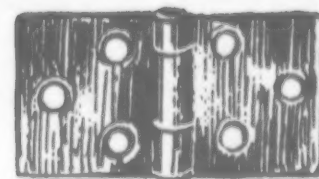
Types of Hinges



Strap



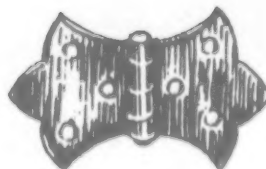
T



Butt



Screw Hook and Strap



Cabinet



Hasp

FASTENERS
UNIT IX

TEST

1. Define fastener.

2. Identify the following types of nails



a. _____



c. _____



e. _____



b. _____



d. _____



f. _____

3. Match the types of nails on the right to the correct use.

- | | |
|---|------------------|
| _____ a. Used for interior finishing
for ceiling, and for cabinet work | 1. Common |
| _____ b. Used in nailing shingles | 2. Box |
| _____ c. Used in nailing plaster board | 3. Shingle |
| _____ d. Used in form construction | 4. Roofing |
| _____ e. Used in nailing galvanized iron | 5. Wire staple |
| _____ f. Used for nailing sheeting, shiplap, and fencing | 6. Flooring |
| _____ g. Used for nailing siding | 7. Plaster board |
| _____ h. Used in flooring work | 8. Hinge |
| _____ i. Used in nailing rolled roofing and composition shingles | 9. Duplex |
| _____ j. Used in fastening hinges | 10. Lead head |
| _____ k. Used in fence construction | 11. Finishing |

4. Select from the list the lengths of nails most commonly used by placing an "X" in the blanks provided.

- | | |
|-------------|--------------|
| _____ a. 2d | _____ h. 10d |
| _____ b. 3d | _____ i. 12d |
| _____ c. 4d | _____ j. 16d |
| _____ d. 5d | _____ k. 20d |
| _____ e. 6d | _____ l. 30d |
| _____ f. 7d | _____ m. 40d |
| _____ g. 8d | _____ n. 60d |

5. Name two coatings for nails.

- a.
- b.

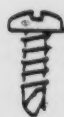
6. Name two materials used to manufacture nails.

- a.
- b.

7. Identify the following types of screw heads.



a. _____



d. _____



b. _____



e. _____



c. _____

8. Identify the following types of screws.



a. _____



b. _____



c. _____

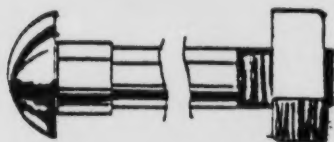


d. _____

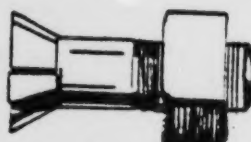
9. Select from the list five things to specify when purchasing screws by placing an "X" in the blank.

- | | |
|--------------------------------------|---|
| ☐ a. Length | ☐ g. Type of head |
| ☐ b. Color | ☐ h. Water proof |
| ☐ c. Size | ☐ i. Finish |
| ☐ d. Quantity | ☐ j. Types of thread |
| ☐ e. Quality | ☐ k. Penny weight |

10. Identify the following types of bolts.



a. _____



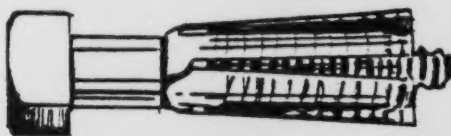
b. _____



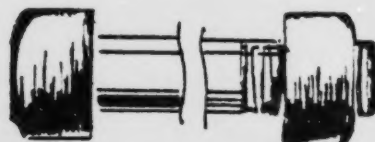
c. _____



d. _____



e. _____



f. _____

11. Match the types of bolts on the right to the correct use.

(NOTE: Bolts may be used more than once.)

- | | |
|---|--------------|
| ☐ a. Used in assembling machinery | 1. Machine |
| ☐ b. Used in fastening wood and other soft materials | 2. Carriage |
| ☐ c. Used in sheet metal work | 3. Stove |
| ☐ d. Used in fastening objects to hollow walls | 4. Plow |
| ☐ e. Used in fastening materials to concrete walls, floors, etc. | 5. Toggle |
| | 6. Expansion |

12. Identify the following types of washers.



a. _____



b. _____

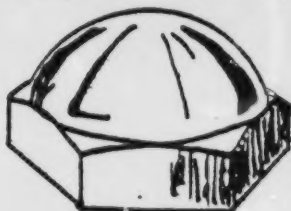


c. _____

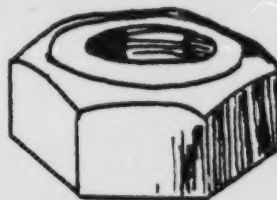


d. _____

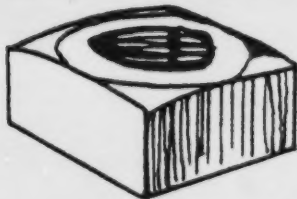
13. Identify the following types of nuts.



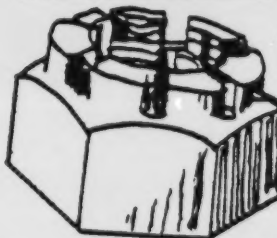
a. _____



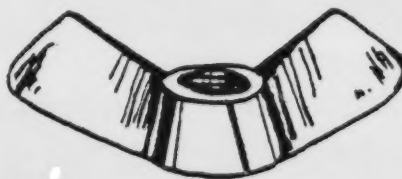
b. _____



c. _____

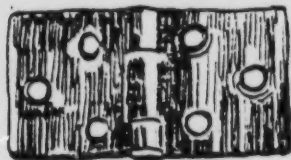


d. _____



e. _____

14. Identify the following types of hinges.



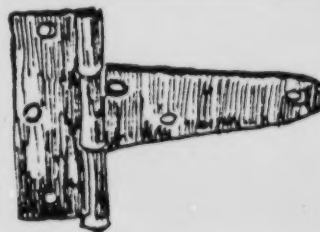
a. _____



b. _____



c. _____



d. _____



e. _____

15. Match the hinge on the right with description of its use.

(NOTE: Some hinges may be used more than once.)

- ____ a. Used when butt end is fastened into a studding
- ____ b. Used in hinging gates
- ____ c. Used in fastening doors and provides a place for a lock
- ____ d. Used in heavy construction
- ____ e. Used in cabinet work

- 1. Strap
- 2. T
- 3. Butt
- 4. Screw hook and strap
- 5. Cabinet
- 6. Hasp

16. Name two types of glue.

a.

b. .

FASTENERS
UNIT IX

ANSWERS TO TEST

1. Any device such as a nail, screw, or bolt used to construct or to give stability to an object.
2.
 - a. Box
 - b. Hinge
 - c. Plaster board
 - d. Roofing
 - e. Shingle
 - f. Wire staple
3.

a. 11	g. 2
b. 3	h. 6
c. 7	i. 4
d. 9	j. 8
e. 10	k. 5
f. 1	
4. e, g, j, k
5.
 - a. Cement
 - b. Galvanized
6.
 - a. Steel
 - b. Aluminum
7.
 - a. Flat
 - b. Round
 - c. Oval
 - d. Pan
 - e. Hex
8.
 - a. Lag
 - b. Round head
 - c. Flat head
 - d. Oval head

- 9. a, c, d, g, i
- 10. a. Carriage
 - b. Plow
 - c. Toggle
 - d. Stove
 - e. Expansion
 - f. Machine
- 11. a. 1, 4
 - b. 2
 - c. 3
 - d. 5
 - e. 6
- 12. a. Lock
 - b. Plain (flat)
 - c. External lock
 - d. Internal-External lock
- 13. a. Cap
 - b. Hexagon
 - c. Square
 - d. Castle
 - e. Wing
- 14. a. Butt
 - b. Strap
 - c. Hasp
 - d. T
 - e. Cabinet
- 15. a. 2
 - b. 4
 - c. 6
 - d. 1
 - e. 3, 5
- 16. a. Casein (white glue)
 - b. Resorcinal resin

METAL WORK
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to measure, mark, cut, and bend metal properly and to drill holes in metal. This will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List four reasons for marking metal.
2. Identify common devices used in marking and measuring metal.
3. List three tools used for cutting cold metal.
4. Match the cold chisel with its use.
5. List the steps used in bending metal.
6. Demonstrate the ability to:
 - a. Cut flat plate metal with a cold chisel.
 - b. Drill holes with a drill press.

METAL WORK
UNIT III

SUGGESTED ACTIVITIES

- I. Instructor:
 - A. Provide students with objective sheet
 - B. Provide students with information and job sheets
 - C. Make transparencies
 - D. Discuss terminal and specific objectives
 - E. Discuss information sheet
 - F. Demonstrate and discuss procedures outlined in job sheets
 - G. Give test
- II. Student:
 - A. Read objectives
 - B. Study information sheet and take notes
 - C. Demonstrate the ability to accomplish the procedures outlined in the job sheets
 - D. Take test

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objective sheet
 - B. Information sheet
 - C. Transparency masters
 - 1. TM 1 - Devices Used in Marking Metal
 - 2. TM 2 - Devices Used in Measuring Metal
 - 3. TM 3 - Devices Used in Both Measuring and Marking Metal
 - 4. TM 4 - Cold Chisels
 - 5. TM 5 - Bending and Shaping Metal
 - 6. TM 6 - Making an Eye With Pipe and Vise
 - D. Job sheets
 - 1. Job Sheet #1 - Cut Flat Metal with a Cold Chisel
 - 2. Job Sheet #2 - Drill Holes with a Drill Press
 - E. Test
 - F. Answers to test

II. References:

- A. Jones, M.M. Shopwork on the Farm. New York: McGraw-Hill Book Co., 1955
- B. Rose, Henry and R.N. Craig. Modern Farm Shop. Austin, Texas; Streck Publishing Co., 1954.
- C. Phipps, Lloyd J. Mechanics in Agriculture. Danville, Illinois: Interstate Printers and Publishers, Inc., 1967.
- D. Wakeman, T.J. and Vernon L. McCoy. The Farm Shop. New York; the Macmillan Co., 1960.
- E. Instructional Materials for Vocational Agriculture I. College Station, Texas: Teaching Materials Center, Agriculture Education Department, Texas A & M University.
- F. Walder, John R. Modern Metalworking. Homewood, Illinois: Goodheart-Willcox Co., 1965.
- G. Farm Welding. Cooperative Extension Service, Kansas State University Manhattan, Kansas XE-E9.

METAL WORK
UNIT III

INFORMATION SHEET

- I. Reasons for marking metal
 - A. Cut
 - B. Drill
 - C. Bend
 - D. Weld
- II. Common devices used in marking and measuring metal (Transparencies 1, 2, and 3)
 - A. Marking
 - 1. Combination square
 - 2. Scratch awl
 - 3. Scriber
 - 4. Center punch
 - 5. Chalk or soapstone
 - 6. Flat file
 - 7. Compass
 - B. Measuring
 - 1. Steel rule
 - 2. Framing square
 - 3. Try square
 - 4. Combination square
 - 5. Steel tape
 - 6. Micrometer
 - (NOTE: The micrometer is used when a high degree of accuracy is necessary.)
 - 7. Calipers
 - 8. Dividers
- III. Tools used for cutting cold metal
 - A. Hacksaw
 - B. Bolt cutter
 - C. Cold chisel

- D. Tinner's snips
- E. Metal shears
- F. Metal band saw

IV. Cold chisels and their uses (Transparency 4)

- A. Standard flat (Most common) - Used to cut sheet metal, bolts, nuts, rivets, and rods
- B. Diamond point - Used for cutting triangle grooves or for marking square corners in grooves
- C. Cape - Used to cut out rectangle grooves or channels
- D. Round nose - Used for cutting oval grooves or channels

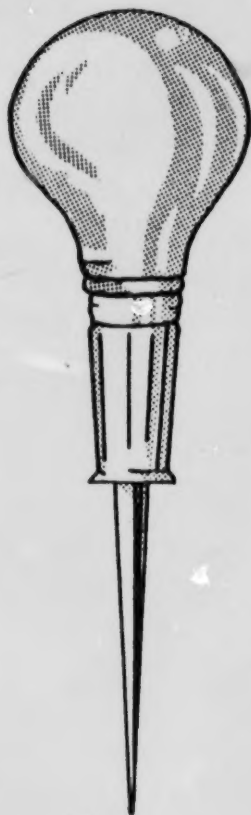
V. Steps in bending metal (Transparencies 5 and 6)

- A. Mark the point
- B. Place the metal in a vise or on the anvil
- C. Bend metal with a hammer
- D. Bend metal at the top of the vise or at the top of the anvil

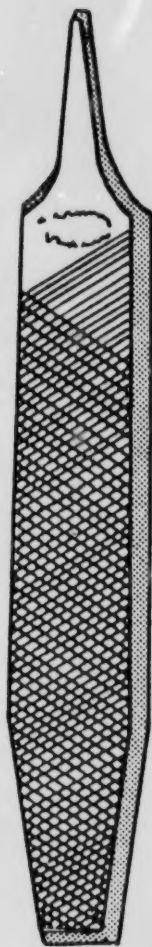
Devices Used in Marking Metal



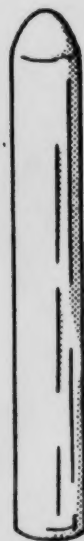
Scriber



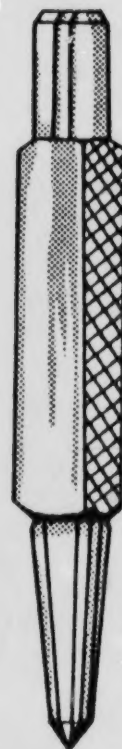
Scratch Awl



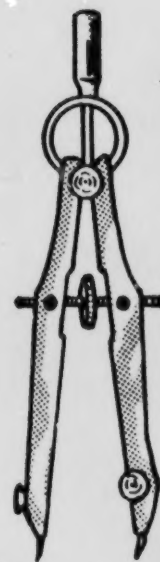
Flat File



Soapstone
or Chalk

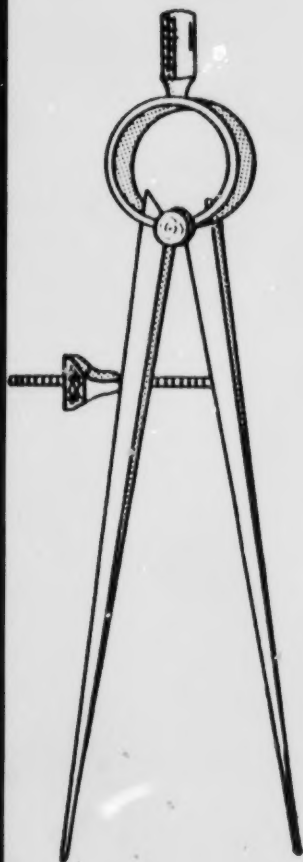


Punch

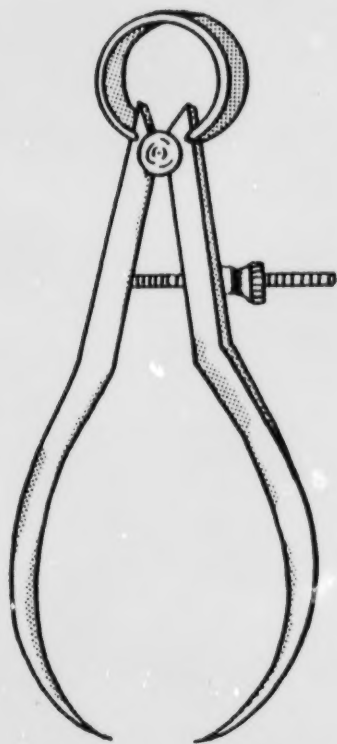


Compass

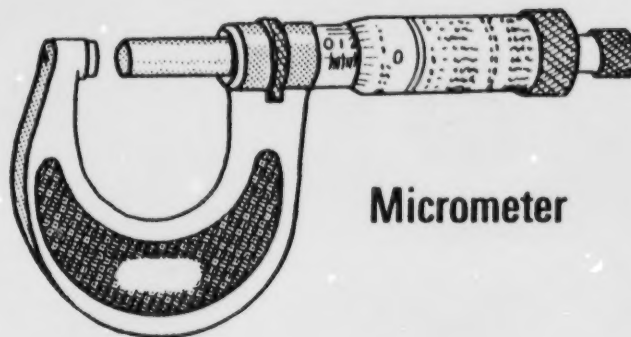
Devices Used in Measuring Metal



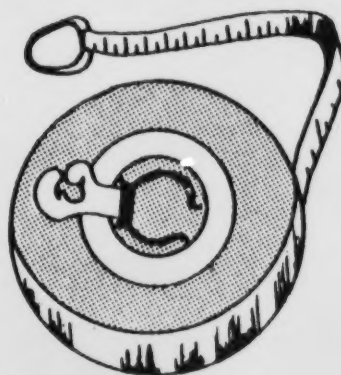
Dividers



Calipers-Outside

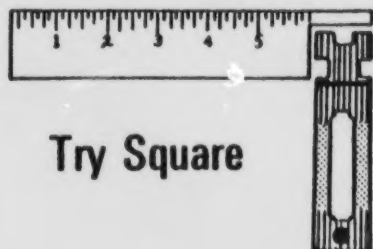


Micrometer

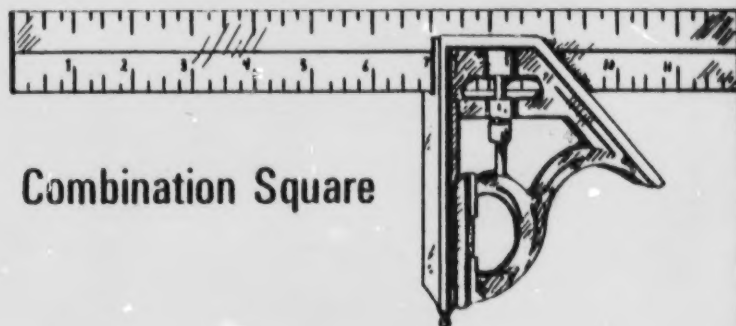


Steel Tape

Devices Used in Both Measuring and Marking Metal



Try Square



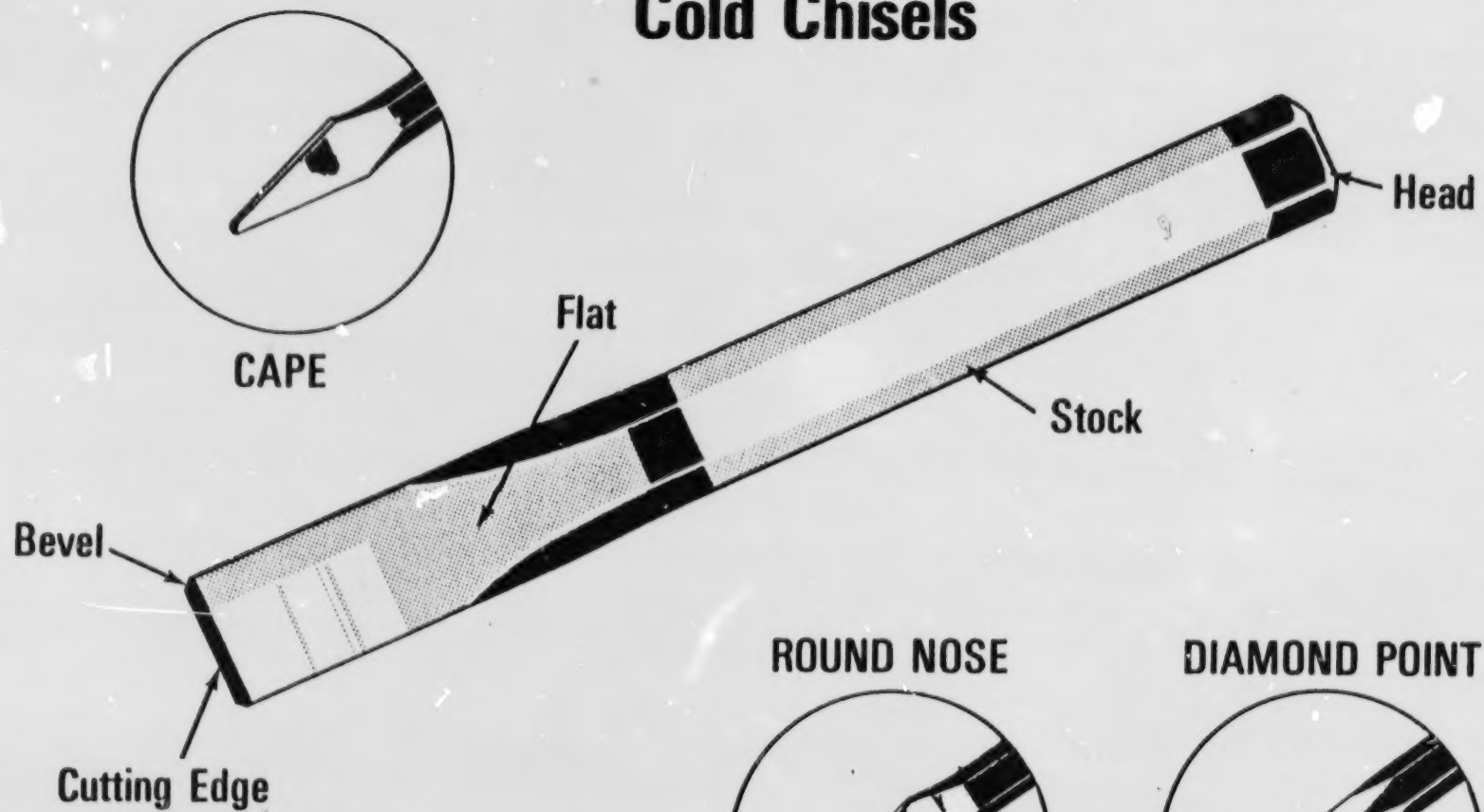
Combination Square



Steel Rule

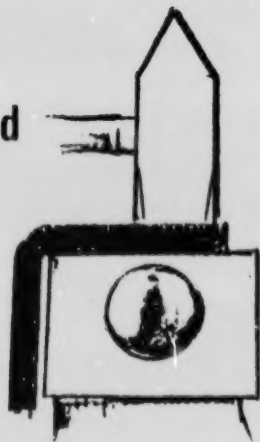
Framing Square

Cold Chisels



Bending and Shaping Metal

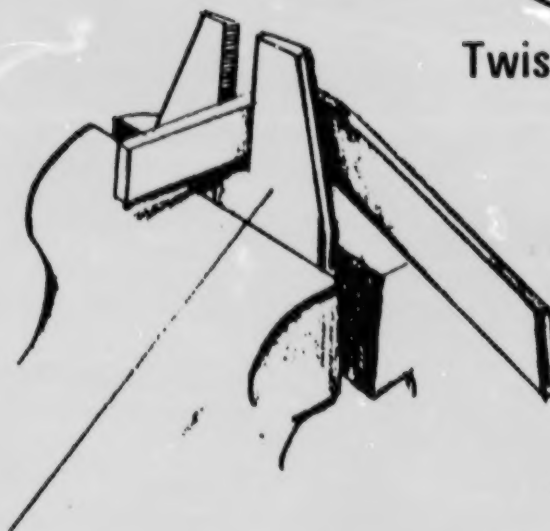
90° Bend
on Anvil



Shape End
on Anvil Horn



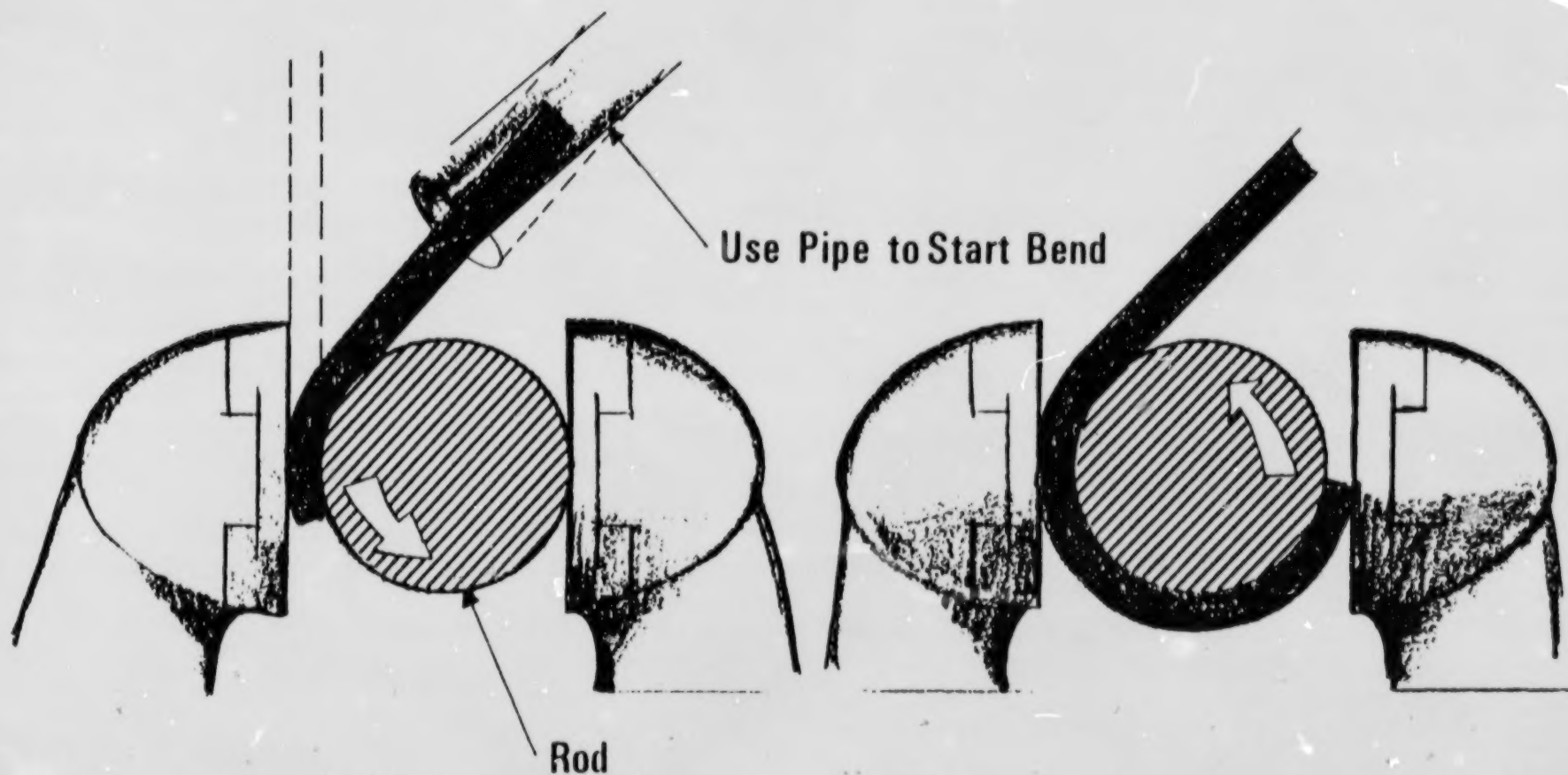
Twisting Square Rod



Bending
Fork

Use Metal Bending Forks

Making an Eye With Pipe and Vise



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METAL WORK
UNIT III

JOB SHEET #1 - CUT FLAT METAL WITH A COLD CHISEL

I. Tools and equipment needed

- A. Marker (such as oval or chalk)
- B. Flat strip of metal
- C. Chisel
- D. Hammer
- E. Vise
- F. Safety goggles

II. Procedure

- A. Mark the metal
- B. Place the metal in the vise with the cutting mark just above the jaws of the vise
- C. Select proper size chisel and hammer
(NOTE: For larger size metal, use a larger chisel and hammer.)
- D. Place the chisel at side of the metal to start the shearing point and drive the chisel with a hammer
- E. Hold the chisel at approximately a 60° angle
- F. Make cuts from each end of the metal to the center and on both sides
- G. Bend metal back and forth until it breaks

III. Diagram of the procedure

Repeat Cut on
Opposite Side



METAL WORK
UNIT III

JOB SHEET #2 - DRILL HOLES WITH A DRILL PRESS

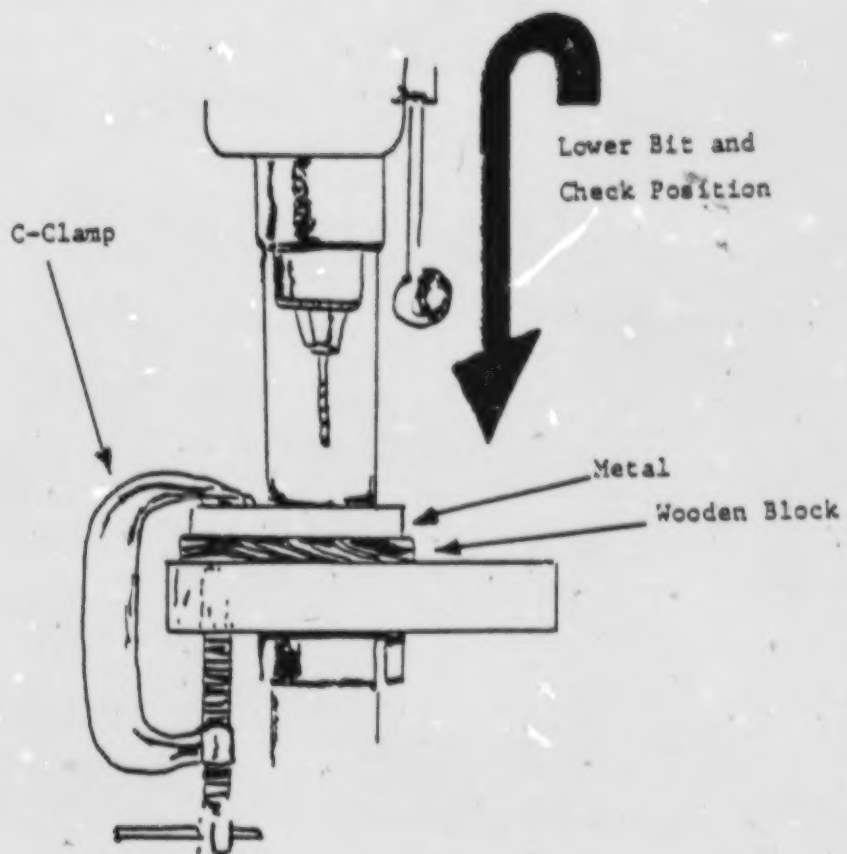
I. Tools and equipment needed

- A. Small piece of flat metal
- B. Center punch
- C. Hammer
- D. Wooden block
- E. Cutting Oil
- F. Clamp
- G. Safety goggles

II. Procedure

- A. Mark the hole with a center punch
- B. Place the metal on a wooden block
- C. Clamp the metal being drilled securely to prevent it from spinning
- D. Feed the bit down to the metal and start drilling
- E. Raise the bit to see if you are drilling in the proper place
- F. Using cutting oil on the drill bit two or three inches above the work, continue drilling

III. Diagram of the procedure



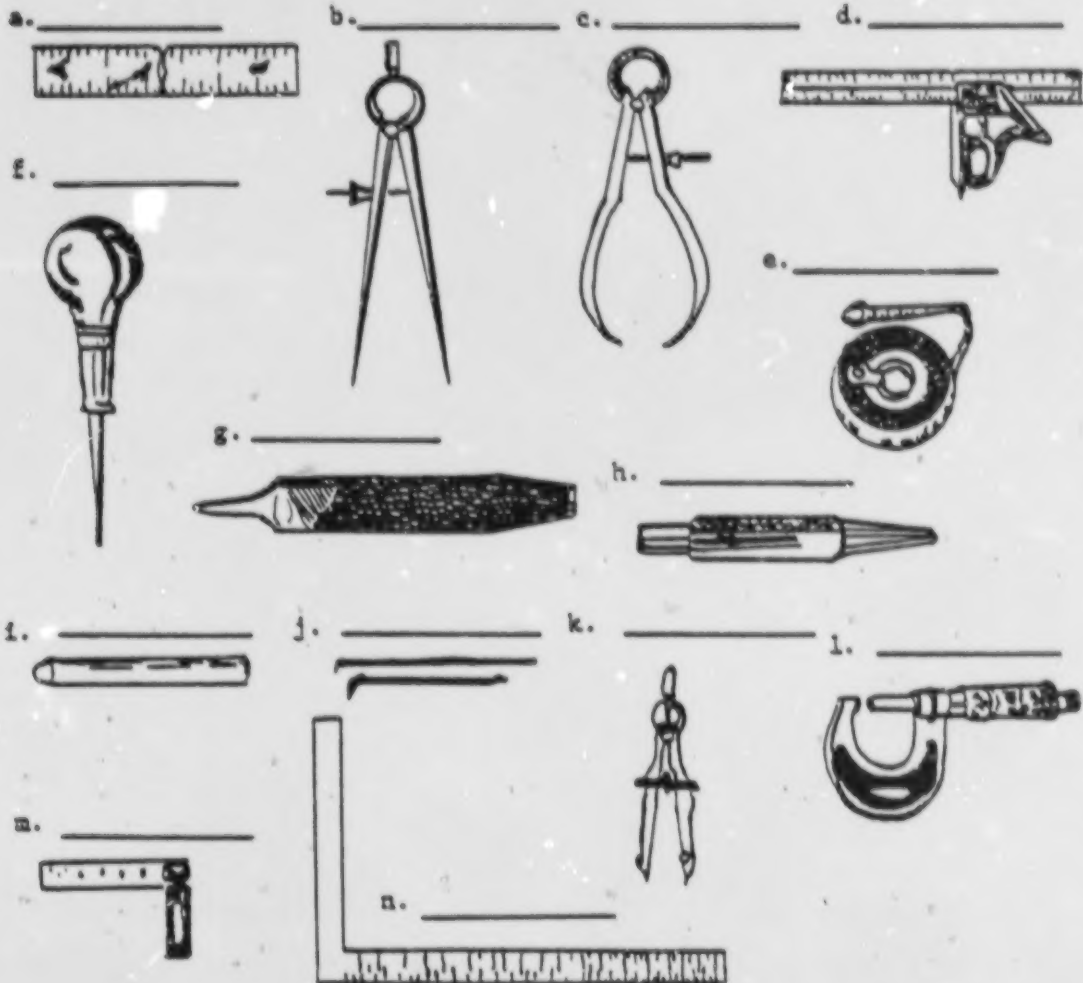
METAL WORK

TEST

1. List four reasons for marking metal.

- a.
- b.
- c.
- d.

2. Identify the following common devices used in marking and measuring metal.



3. List three tools used for cutting cold metal.

- a.
- b.
- c.

4. Match the uses on the right with the appropriate chisel on the left.

- | | |
|------------------------|---|
| _____ a. Diamond point | 1. Cuts triangle grooves |
| _____ b. Cape | 2. Cuts long grooves |
| _____ c. Standard flat | 3. Cuts oval grooves |
| _____ d. Round nose | 4. Cuts narrow grooves |
| | 5. Cuts rectangle grooves |
| | 6. Cuts sheet metal, bolts,
nuts, rivets, and rods |

5. List the steps used in bending metal.

- a.
- b.
- c.
- d.

6. Demonstrate the ability to:

- a. Cut flat plate metal with a cold chisel.
- b. Drill holes with a drill press.

METAL WORK
UNT
ANSWERS TO TEST

1.
 - a. Cut
 - b. Drill
 - c. Bend
 - d. Weld
2.
 - a. Steel rule
 - b. Dividers
 - c. Calipers
 - d. Combination square
 - e. Steel tape
 - f. Scratch awl
 - g. Flat file
3. Any three of the following
 - a. Hacksaw
 - b. Bolt cutter
 - c. Cold chisel
 - d. Tinner's snips
 - e. Metal shear
 - f. Metal band saw
 - g. Flat file
 - h. Center punch
 - i. Chalk or soapstone
 - j. Scriber
 - k. Compass
 - l. Micrometer
 - m. Try square
 - n. Framing square
4.
 - a. 1
 - b. 5
 - c. 3
 - d. 3
5.
 - a. Mark the point
 - b. Place the metal in a vise or on the anvil
 - c. Bend metal with a hammer
 - d. Bend metal at the top of the vise or at the top of the anvil
6. Performance skills will be evaluated to the satisfaction of the instructor.

BLUEPRINT READING
UNIT I

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to identify a pictorial view as used on a blueprint. He should be able to demonstrate the fundamentals of blueprint reading by drawing a pictorial view and a three-view sketch of a specified rectangular block. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion, the student should be able to:

1. Indicate in writing the purpose of a blueprint.
2. List the three major views of a pictorial drawing.
3. Name the three basic elements of a blueprint.
4. Match the basic types of dimensions with their uses.
5. Identify six common types of lines used in a blueprint.
6. Match fifteen blueprint abbreviations with their corresponding identifications.
7. Draw a simple three-view sketch of a rectangular block 8" long by 1" wide by 1/2" thick with correct dimensions.

BLUEPRINT READING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor

- A. Provide students with objective sheet
- B. Provide each student with information and assignment sheets
- C. Make transparencies
- D. Discuss terminal and specific objectives
- E. Discuss information and assignment sheets
- F. Give test

II. Student

- A. Read objectives
- B. Study information sheet
- C. Obtain drawing paper, ruler, and tri-square protractor to be used in drawing plans
- D. Complete assignment sheet
- E. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit

- A. Objectives
- B. Information sheet
- C. Transparency masters
 - TM 1--Converting a Pictorial View into a Three-Sided View
 - TM 2--Types of Dimensions on a Blueprint
 - TM 3--Basic Lines Used in Blueprint Reading
 - TM 4--Use of Lines on a Blueprint Reading
- D. Assignment sheet #1--Drawing a Three-View Sketch
- E. Test
- F. Answers to test

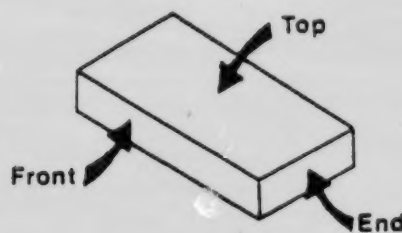
II. References

- A. Bennett, A.E., and Louis J. Siy, Blueprint Reading for Welders, Delmar Publishers, Inc.
- B. Sacks, Raymond, Theory and Practice of Arc Welding, Van Nostrand Reinhold Company. OK000498
- C. How To Read Shop Drawings, The Lincoln Electric Company, Cleveland, Ohio. OK000620

BLUEPRINT READING
UNIT I

INFORMATION SHEET

- I. Purpose of blueprint - To convey a message from the draftsman to the workman indicating shapes and dimensions of objects to be built
- II. Major view of a pictorial drawing (Transparency 1)
 - A. Top
 - B. Front
 - C. End



- III. Basic elements of blueprint
 - A. Lines - Give shape and dimensioning of the object
 - B. Dimensions - Give size and location of various segments of items being constructed
 - C. Notes - Give details of construction not shown by lines
- IV. Types of dimensions (Transparency 2)
 - A. Overall - Describes a total distance such as the complete length, width, or thickness of a part
 - B. Size - Give information concerning the size of a part
 - C. Location - Gives information concerning the location of some detail of construction, such as a hole

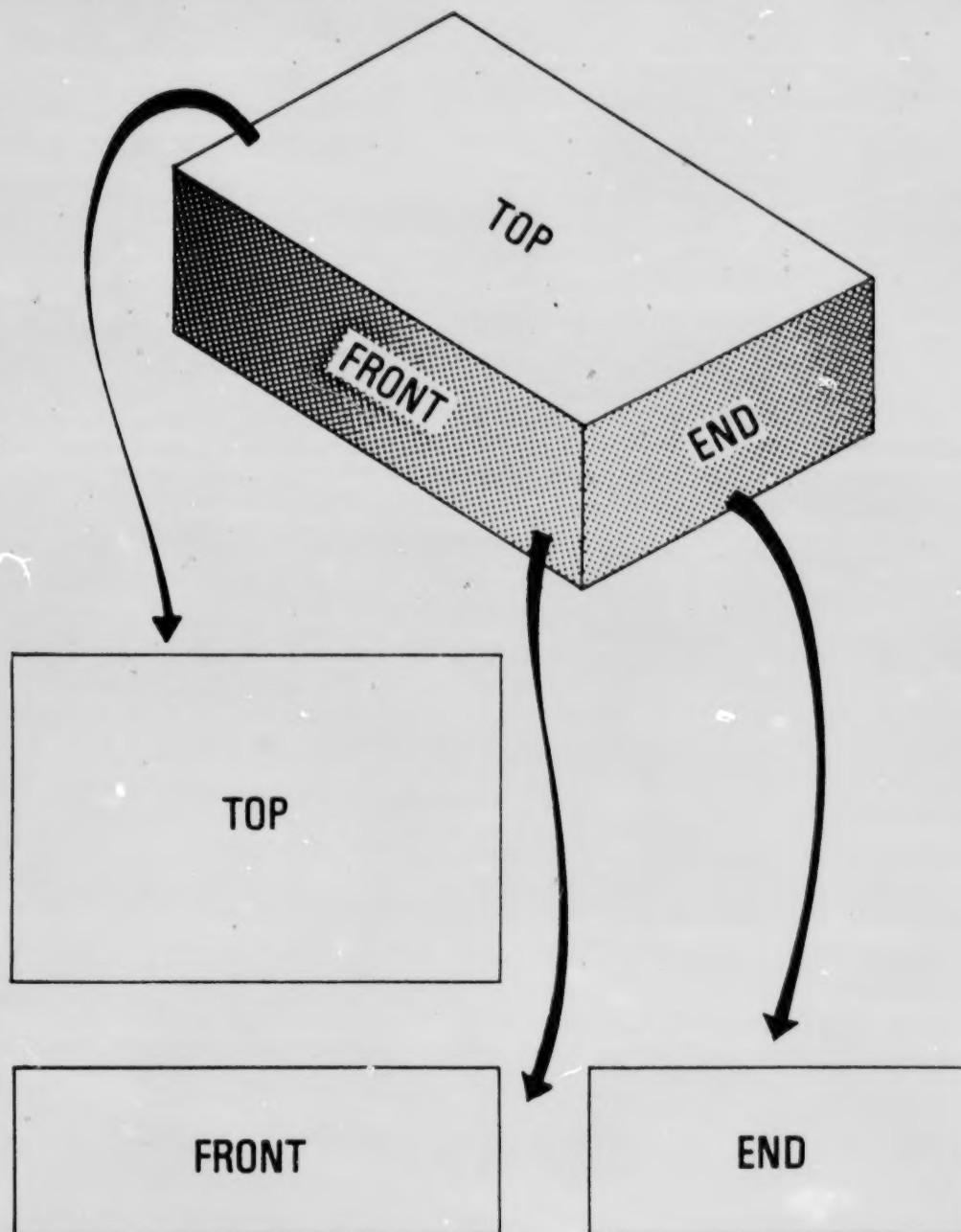
V. Basic lines used in blueprint reading (Transparencies 3 and 4)

- A. Border line - Serves as a frame for the blueprint
- B. Object line - Indicates the outline of an object
- C. Hidden line - Represents an edge that cannot be seen from the outside of the object
- D. Extension line - Indicates the exact distance the dimension describes
- E. Dimension line - Extends between the extension lines to clarify dimensions
- F. Center line - Used to locate the center of a circle or a curved surface
- G. Pointer line - Shows the detail described by a dimension of note
- H. Cutting plane line - Used to show the shape of complicated parts
- I. Break line - Used to show interior detail

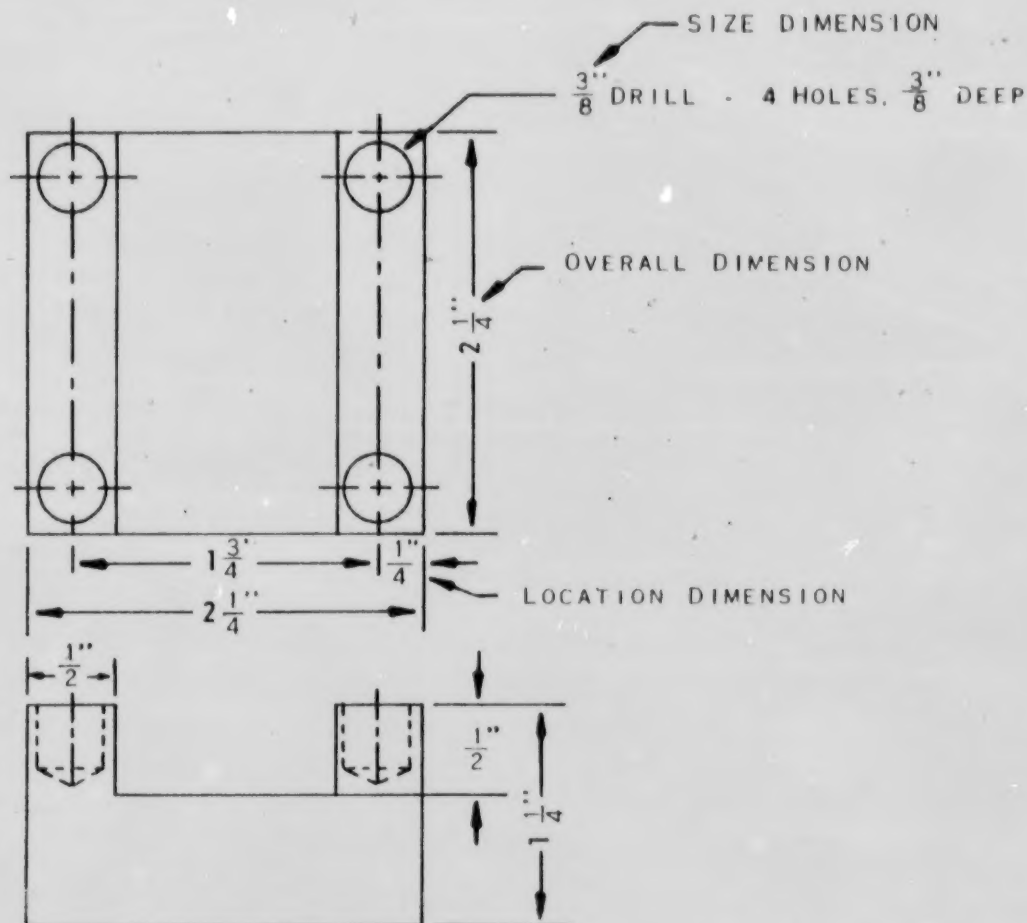
VI. Common abbreviations used on blueprints

- | | |
|------------------------------|--|
| C. I. = Cast Iron | S. A. E. = Society of Automotive Engineers |
| C. C. = Center to Center | Sq. = Square |
| C. Bore = Counterbore | U. S. S. = United States Standard |
| C. R. S. = Cold Rolled Steel | N. T. S. = Not to Scale |
| C.S. = Cast Steel | Cir = Circular |
| Csk. = Countersink | Cyl = Cylinder |
| Dia. = Diameter | Deg or $^{\circ}$ = Degree(s) |
| F = Finish | Ga = Gauge |
| F. A. O. = Finish All Over | GI = Galvanized Iron |
| Fin. = Finish | I = I Beam |
| F. S. = Full Size | In. of " = Inch(es) |
| F. S. D. = Full Size Detail | Mal I = Malleable Iron |
| Hex = Hexagon | Std = Standard |
| I. D. = Inside Diameter | Stl = Steel |
| N. C. = National Coarse | Stl C = Steel Casting |
| N. F. = National Fine | Thd or Thds = Thread(s) |
| No. or # = Number | WI = Wrought Iron |
| O. C. = On Center | Br# = Brass, SAE# |
| O. D = Outside Diameter | Bro# = Bronze, SAE# |
| R. or Rad = Radius | Chfr = Chamfer |
| Req'd = Required | |

CONVERTING A PICTORIAL VIEW INTO A 3-SIDED VIEW



TYPES OF DIMENSIONS ON A BLUEPRINT



BASIC LINES USED IN BLUEPRINT READING

Border Line



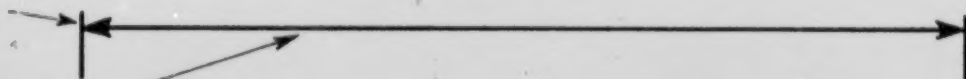
Object Line



Hidden Line



Extension Line



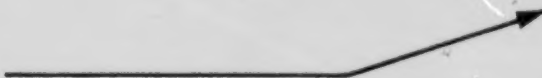
Dimension Line



Center Line



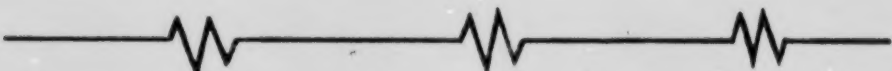
Leader Line



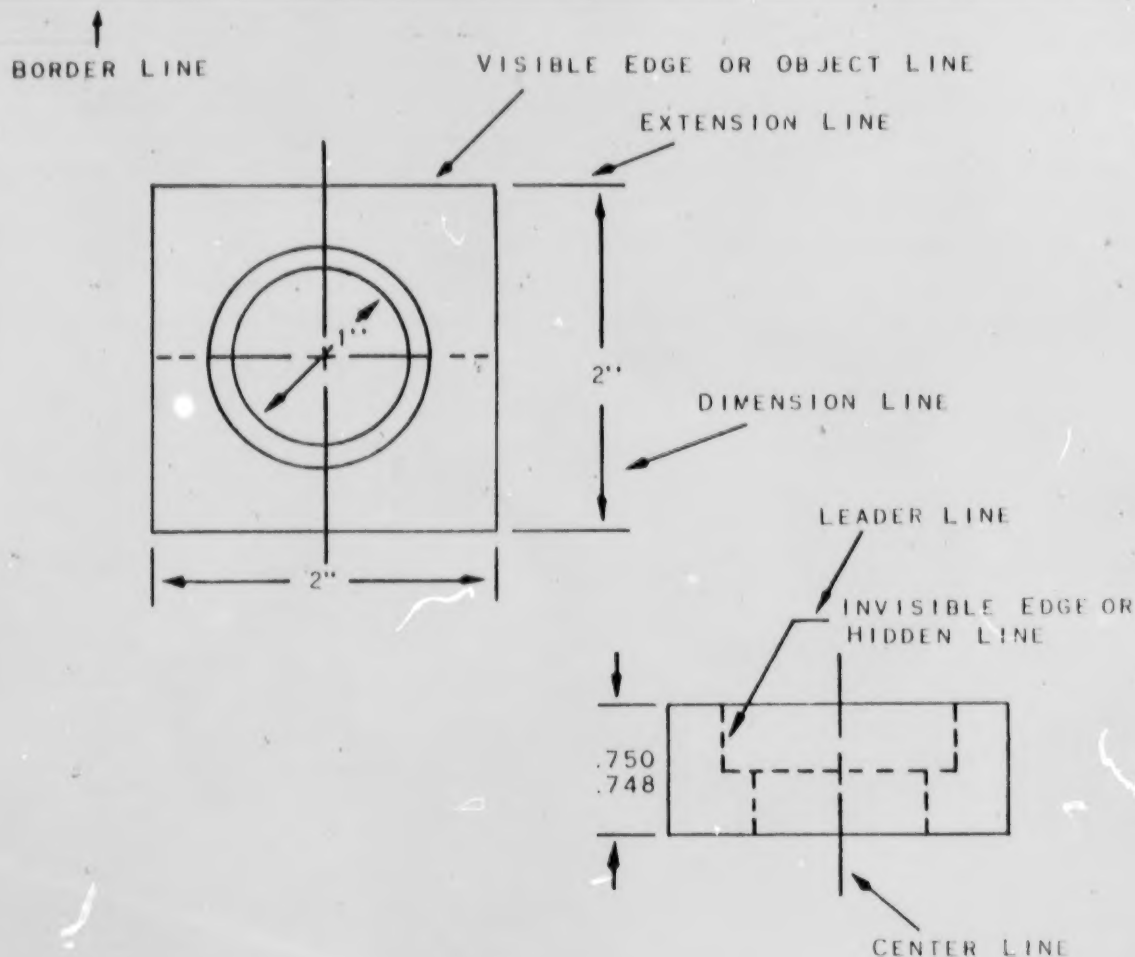
Cutting Plane Line



Break Line



USE OF LINES ON A BLUEPRINT



BLUEPRINT READING
UNIT I

ASSIGNMENT SHEET #1--DRAWING A THREE-VIEW SKETCH

Draw a three-view sketch of a rectangular block using the following dimensions. Be sure to show your dimensions.

A. 10" long by 2" wide by 1" thick

B. 12" long by 1" wide by $\frac{1}{4}$ " thick

BLUEPRINT READING
UNIT I

TEST

1. Write the purpose of a blueprint for a workman.
2. List the three major views of a blueprint.
 - a.
 - b.
 - c.
3. Draw the three major views of a sketch of a rectangular block 8" long by 1" wide by 1/2" thick, using correct dimensions.
4. Name the three basic elements of a blueprint.
 - a.
 - b.
 - c.

5. Match the basic type of dimension with its proper function.

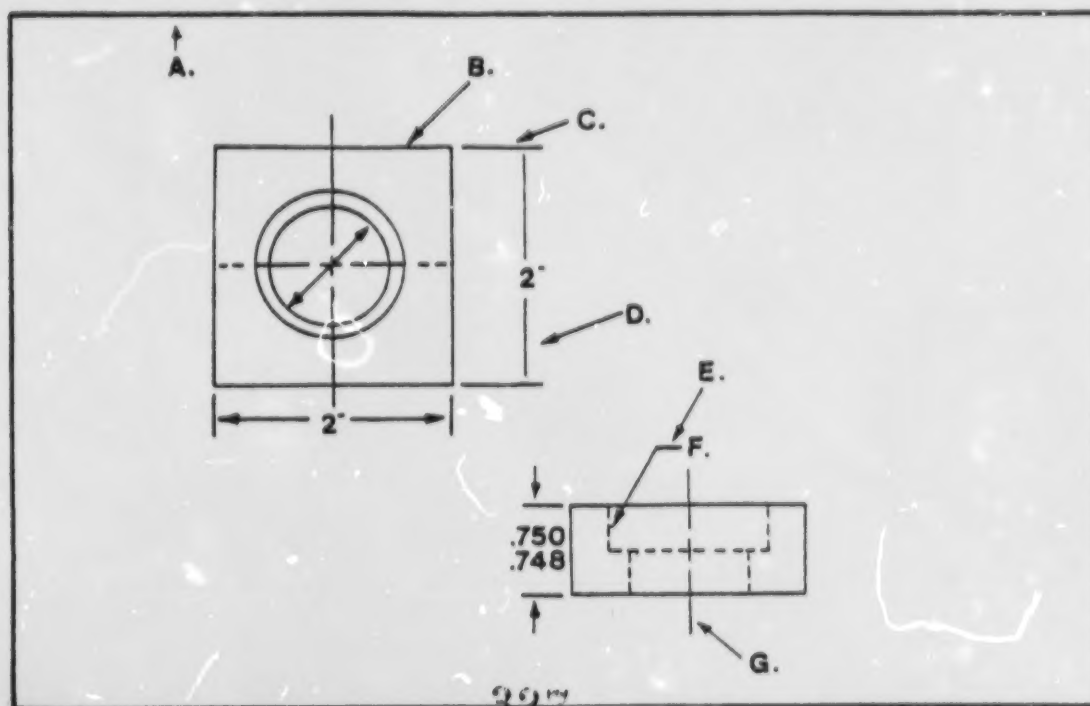
- ___ a. Location dimension
- ___ b. Overall dimension
- ___ c. Size

- 1. Gives information concerning the size of a part
- 2. Gives information concerning the location of some detail of construction, such as a hole
- 3. Gives the total distance, such as the complete length, width, or thickness of a part

6. Correctly identify the following lines.

- | | |
|---|----------|
| a. _____ | a. _____ |
| b. _____ | b. _____ |
| c. and d.  | c. _____ |
| e. _____ | d. _____ |
| f. _____ | e. _____ |
| | f. _____ |

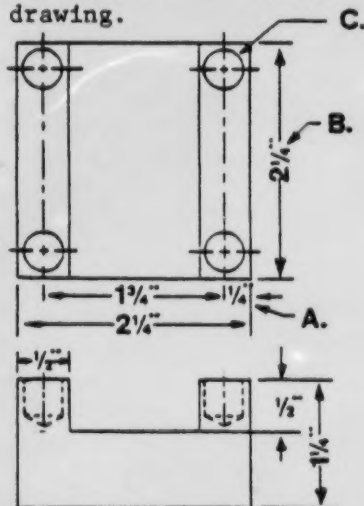
7. Correctly identify the common lines on the following blueprint drawing.



7. a. _____
 b. _____
 c. _____
 d. _____

- e. _____
 f. _____
 g. _____

8. Correctly identify the basic types of dimensions on the following blueprint drawing.



- a. _____
 b. _____
 c. _____

9. Match the following abbreviations with the correct identification.

- ____ a. Std
 ____ b. Csk.
 ____ c. O. D.
 ____ d. Mal I
 ____ e. Hex
 ____ f. Cyl
 ____ g. Br#
 ____ h. Stl
 ____ i. Sq.
 ____ j. Chfr
 ____ k. Deg
 ____ l. Cir

1. Finish
 2. Thread
 3. Chamfer
 4. Bronze, SAE#
 5. Steel
 6. Brass, SAE#
 7. Wrought Iron
 8. Galvanized Iron
 9. Circular
 10. Radius
 11. Standard
 12. National Coarse

m. Fin
 n. R.
 o. N. C.

- 13. Hexagon
- 14. Degree
- 15. Square
- 16. Countersink
- 17. Outside Diameter
- 18. Cylinder
- 19. Malleable Iron
- 20. Cast Steel

BLUEPRINT READING
UNIT I

ANSWERS TO TEST

1. To convey a message from the draftsman to the workman indicating shapes and dimensions of objects to be built.
2.
 - a. Top
 - b. Front
 - c. End
3. To be evaluated by the instructor.
4.
 - a. Lines
 - b. Dimensions
 - c. Notes
5.
 - a. 2
 - b. 3
 - c. 1
6.
 - a. Hidden
 - b. Center
 - c. Dimension
 - d. Extension
 - e. Object
 - f. Border
7.
 - a. Border line
 - b. Object line
 - c. Extension line
 - d. Dimension line
 - e. Leader line
 - f. Hidden line
 - g. Center line

8. a. Location dimension
b. Overall dimension
c. Size dimension

9. a. 11
b. 16
c. 17
d. 19
e. 13
f. 18
g. 6
h. 5
i. 15
j. 3
k. 14
l. 9
m. 1
n. 10
o. 12

COMBINE OPERATION AND MAINTENANCE
UNIT XIII

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to match terms associated with combines and identify the parts of a combine. The student should be able to match causes with poor combine harvesting operation and demonstrate preparation checking. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with combines.
2. Identify the parts of a combine.
3. List the 5 jobs the combine performs.
4. Match the proper operation and adjustment to eliminate field losses.
5. List four factors that will affect combine harvesting.
6. Demonstrate procedure for maintenance check of a combine.
7. List the path material takes from cutterbar to straw spreader.

COMBINE OPERATION AND MAINTENANCE
UNIT XIII

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and assignment sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information and assignment sheets.
- F. Plan field trip to equipment dealer.
- G. Give test.

II. Student:

- A. Read objectives.
- B. Study information and assignment sheets.
- C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Suggested activities
- C. Information sheets
- D. Transparency master
 - 1. TM 1 - Parts of a combine
- E. Job sheet
 - 1. Job Sheet #1 - Combine harvester maintenance
- F. Assignment sheet
 - 1. Assignment Sheet - Path material takes from cutterbar
- G. Answer to assignment sheet
- H. Test
- I. Answers to test

II. References:

- A. Fundamentals of Machine Operation--Combine Harvesting, John Deere Service Publications Dept. F, John Deere Road, Moline Illinois 61265
- B. Hunt, Donnell, Farm Power and Machinery Management, Fifth ed., Iowa State University Press, Ames, Iowa.

COMBINE OPERATION AND MAINTENANCE
UNIT XIII

INFORMATION SHEET

I. Terms and definitions

- A. Level-land combine - Combine supported by a fixed drive axle. Separator tilts with the contour of the ground
- B. Hillside combine - Combine is supported by pivoting axles which adjust to changing slopes hillsides
- C. Pull-type combine - Combine is drawn by a tractor
- D. Bat-type or slot-type reel - Consists of three to eight slots made of wood or steel
- E. Pickup reel - Has several steel tines or fingers attached to the slots

II. Parts of a combine (Transparency 1)

III. Combines perform the following basic crop harvesting functions

- A. Cutting and feeding
- B. Threshing
- C. Separating
- D. Cleaning
- E. Handling

IV. Factors which affect combine harvesting

- A. Skill of the operator
- B. Condition of the crop and field
- C. Adjustment of the combine
- D. Proper operating speed of harvesting componenets
- E. Ground speed of the combine
- F. Width of the header

V. Path material takes from cutterbar to straw spreader (Assignment Sheet #1)

VI. Maintenance check of a combine (Job Sheet #1)

VII. Signs of poor combine harvesting

- A. High cutterbar loss

- B. High cylinder loss
- C. High rack loss
- D. High show loss
- E. Poorly cleaned grain
- F. Cracked grain
- G. Cylinder wrappings

INFORMATION SHEET

GUIDE FOR TEACHING: Maintenance & Repair of Combine

PROBLEM: Trouble Shooting, Cause, Remedy Check Sheet

Trouble	Probable Cause	Remedy	Method for Checking
High Cutterbar Loss	Heads left standing Reel Shattering grain Reel throwing out grain Grain not being laid back on platform canvas Tangling of grain, vines and weeds on outer ends of the slates	Lower cutterbar to cut low-growing or lodged crops. Decrease reel speed by changing sprockets. Raise reel. Fill in from reel slat toward center of reel with 1/4" mesh hardware cloth. Slow reel down. Move reel back and down. Add pieces of belt to reel slat to brush cutterbar. Unite the outer ends of the slates with an 8" band of sheet iron and slow down the reel.	- Count the number of kernels per sq. ft. on the ground under the combine - Count the number of kernels in standing grain per sq. ft. (Not cutterbar losses, but shattered grain.) - Take difference between 1 and 2 for cutterbar loss.
High Cylinder Loss	Low cylinder speed Too much clearance between cylinder and concaves Crop too wet	Increase cylinder speed until you just begin to get a little breaking of straw. Decrease cylinder-concave clearance until occasionally a kernel will be found in the head. Wait until grain is about 13% moisture	- Catch all material leaving back end of combine in a box or canvas. - Count unthreshed kernels in heads of this material - Determine the number of kernels/sq. ft. of area taken.

INFORMATION SHEET

Trouble	Probable Cause	Remedy	Method for Checking
High Rack Loss	Rack speed too high or too low Overloading Breaking up material too much with cylinder (Overthreshing) Rack openings plugged	Set PTO to manual's recommendation Set rack to manual's recommendation Raise cutterbar, reduce rate of travel, and/or avoid overthreshing by increasing cylinder-concave clearance. Increase cylinder-concave clearance until little or no breaking. Decrease the cylinder speed slightly Clean rack openings. Reduce rate of travel. Avoid overloading.	1. Catch all material coming out back end of machine in a tray 24" x 60" or a canvas for about 10' forward travel 2. Shake loose grain out of straw 3. Determine number of kernels per sq. ft. of acre taken 4. Check table. Should have less than 1.4% of total yield
High Shoe Loss	Overloading the shoe (Overthreshing) Shoe speed too high or too low Improperly directed wind blast Too much wind blast	Increase cylinder-concave clearance Decrease cylinder speed. Reduce rate of travel. Raise cutterbar. Do only one at a time until you get loss to 3-4 kernels per sq. ft. of area taken. Check PTO speed with operator's manual. Change wind blast to keep chaffy material "floating" to rear. Reduce wind blast to where only a small amount of chaffy material appears in grain rack.	1. Catch only material from the shoe in tray. (Use a canvas to keep rack straw off.) On some machines you may have to subtract rack loss from total loss. 2. Determine number of kernels/sq. ft. area. 3. Check table same as for rack.

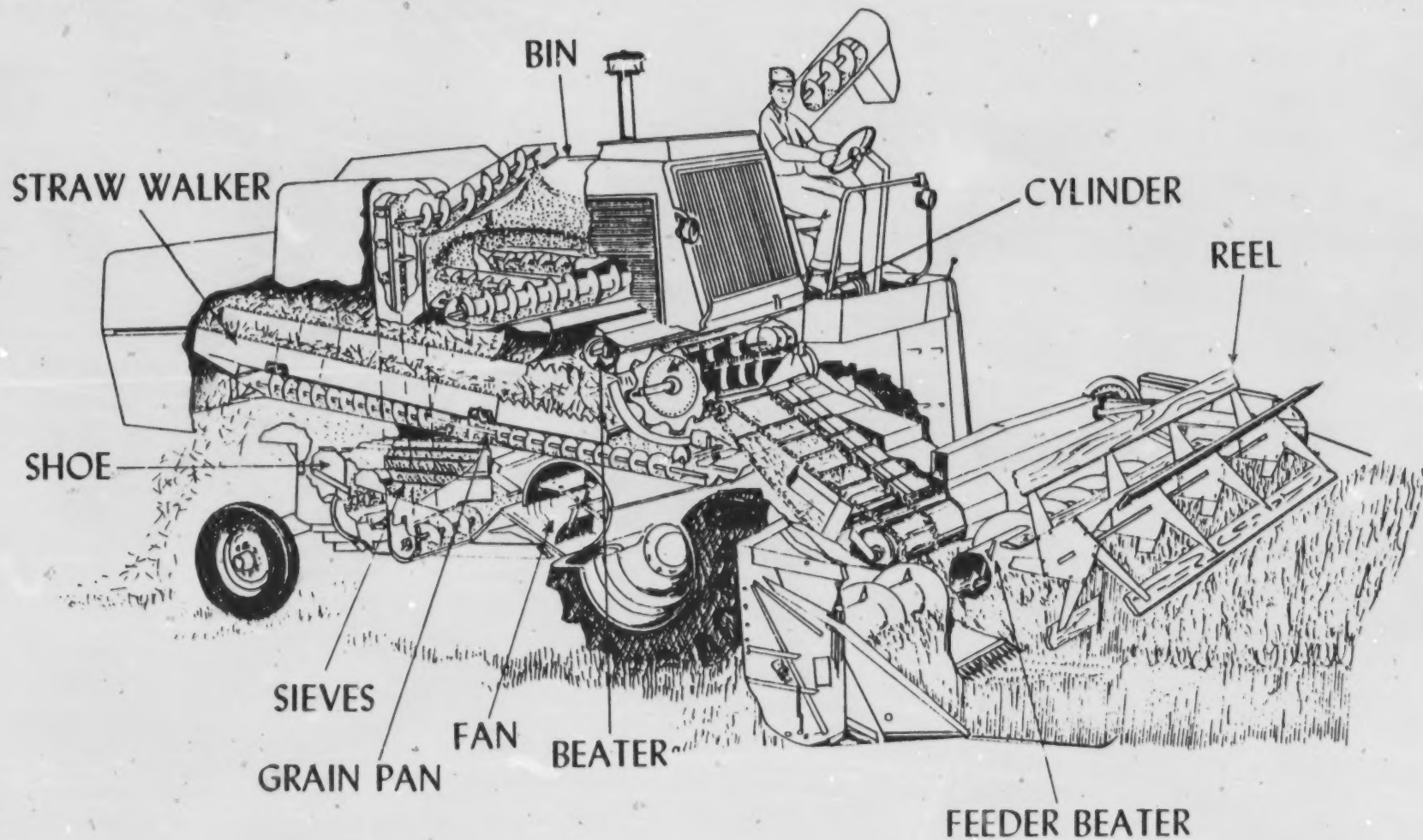
INFORMATION SHEET

Trouble	Probable Cause	Remedy	Method for Checking
High Shoe Loss (Cont.)	Sieve openings closed too much Sieve openings plugged	Open chaffer or upper sieve until about 0.4% of total yield is passing onto ground. Clean the sieves. Change air blast to keep chaff floating.	
Poorly Cleaned Grain	Overthreshing Overloading Sieve open too much Insufficient wind blast	Increase cylinder-concave clearance until little straw breaking and a few unthreshed kernels found over the rack. Reduce rate of travel, raise cutter-bar or cut a narrower swath particularly on PTO machine Close lower sieve on notch. Increase the wind blast one notch and direct it toward the forward end of the sieves.	1. Observe the grain in the grain tank for chaff and foreign materials 2. Check tailings for large amounts of grain 1. Large amounts of heavy dirt in grain 1. Chaff matts on sieves 2. Poor separation
Cracked Grain	Too little cylinder-concave clearance High cylinder speed Too much grain returned to cylinder in the tailings	Increase cylinder-concave clearance until little or no cracked kernels appear and cylinder losses are not excessive. Reduce to manual recommended speed Open the lower sieve slightly	1. Observe grain in tank for cracked kernels 1. Check with tachometer under no load

INFORMATION SHEET

Trouble	Probable Cause	Remedy	Method for Checking
Cracked Grain (Cont.)	Loose elevator chains Shelling plate too close	Take up slack in elevator chains Increase the clearance until little or no cracked kernels appear.	1. Check grain before entering elevator against grain in the tank
Cylinder Wrappings	Grain tough, damp, or heavy growth of weeds Stripping bar too far from cylinder	Increase the cylinder speed slightly increase the beater speed slightly, reduce rate of travel or raise cutterbar Adjust stripping bar just close enough to prevent wrapping.	1. Check Cylinder

Combine



COMBINE OPERATION AND MAINTENANCE
UNIT XIII

ASSIGNMENT SHEET #1 - PATH MATERIAL
TAKES FROM CUTTERBAR

List the path each material takes from cutterbar to straw spreader or grain tank by placing parts of combine selected under each material in proper order.

Materials				Parts of Combine
Tailings	Straw	Clean Grain	Chaff	Reel Cutter Auger Feeder Conveyer Cylinder Concave Rotary Deflector Straw Walker Grain Auger Chaffer Sieve Tail elevator Straw Spreader

COMBINE OPERATION AND MAINTENANCE
UNIT XIII

ANSWERS TO ASSIGNMENT SHEET #1

Path material takes from cutterbar to straw spreader or grain tank

<u>Tailings</u>	<u>Straw</u>	<u>Clean Grain</u>	<u>Chaff</u>
Reel	Reel	Reel	Reel
Cutter	Cutter	Cutter	Cutter
Auger	Auger	Auger	Auger
Feeder Conveyer	Feeder Conveyer	Feeder Conveyer	Feeder Conveyer
Cylinder	Cylinder	Cylinder	Cylinder
Concave	Concave	Concave	Concave
Rotary deflection	Rotary deflection	Rotary deflection	Rotary deflection
Straw Walker	Straw Walker	Straw Walker	Straw Walker
Grain Auger	Straw Spreader	Grain Auger	Grain Auger
Chaffer		Chaffer	Chaffer
Sieve		Sieve	Sieve
Tailer elevator		Clean Grain Elevator	Straw Spreader
Cylinder		Grain Tanks	

COMBINES
UNIT XIII

JOB SHEET #1--MAINTENANCE CHECK LIST

COMBINE HARVESTER-THRESHER

MANUFACTURER _____ YEAR _____
 NAME _____ SERIAL NO. _____
 TYPE _____ MODEL NO. _____
 Estimated Value of Machine When Received _____
 Estimated Value of Reconditioned Machine _____

REPAIR

Check each part carefully and make notation of conditions such as loose, worn, bent cracked, broken, missing, dirt, rust, frozen, etc.

	Condition as Found	Part Required		How Corrected? (Replaced, Straight- ended, welded, etc. Cost	
		Part Number	Cost		
A. PLATFORM					
1. Guards					
2. Ledger plates					
3. Wearing plates					
4. Knife clips					
5. Knife Sections					
6. Pitman shaft					
7. Pitman bearings					
8. Pitman drive chain or belt					
9. Pitman drive idler					
10. Auger bearings or canvas					
11. Auger chain or belt					
12. Auger drive idler					
13. Reel batts					
14. Reel bearings					
15. Reel chain idler					
16. Platform lift supports					
17. Lift mechanism					
18. Feeder raddle					
19. Feeder idler bearings					
20. Feeder drive shaft bearings					
21. Reel slip clutch					
22.					
23.					
B. THRESHER					
1. Front beater					
2. Front beater shaft bearings					
3. Front beat idler					
4. Cylinder rasp bars					
5. Belt, cylinder					
6. Belt idler					
7. Grate bars (concave)					
8. Cylinder shaft bearings					
9. Rear Beater					
10. Beater grate					
11. Idler, rear beater					
12. Rear beater shaft bearings					

JOB SHEET #1

B. THRESHER (Continued)

	Condition as Found	Part Required		How Corrected? (Replaced, Straight- ened, welded, etc. Cost	
		Part Number	Cost		
13. Return elevator shaft bearings					
14. Return elevator chain and flites					
15. Return elevator auger shaft bearings					
16. Upper return elevator idler bearings					
17.					
18.					

C. SEPARATOR

1. Separator check flap					
2. Grain pan					
3. Grain pan front augers					
4. Chaffer					
5. Chaffer extension					
6. Lower sieve					
7. Straw walker					
8. Straw walker bearings					
9. Straw walker crank bearings					
10. Rear hanger bearings					
11. Grain pan shaker pitman					
12. Grain pan shaker bearings					
13. Pan shaft bearings					
14. Fan housing					
15. Fan batts					
16. Straw spreader					
17. Spreader belt					
18. Belt idler					
19. Bearings					
20.					
21.					

D. BIN ELEVATOR

1. Chain and flites					
2. Bin elevator chain idler					
3. Upper bin elevator bearings					
4. Lower bin of elevator bearings					
5. Grain bin auger bearings					
6. Grain bin auger drive belt					
7. Grain bin auger belt idler					
8.					
9.					
10.					

JOB SHEET #1

E. DRIVE	Condition as Found	Part Required		How Corrected? (Replaced, Straightened, welded, etc. Cost
		Part Number	Cost	
1. Wheel bearings				
2. Variable speed				
3. Brakes				
4. Differential				
5. Tires				
6. Universal joints				
7. Drive chain or belt				
8. Transfer cases				
9.				
10.				

Total Repair Costs

II. ADJUSTMENT

A. PLATFORM

	Adjustment as Found	Recommended in Operator Manual	Corrected (Yes, No)
1. Register			
2. Auger clearance			
3. Reel clearance			
4. Reel batts			
5. Reel chain drive			
6. Reel chain idler			
7. Feeder chain			
8.			

B. THRESHER

1. Cylinder rasp bars			
2. Cylinder belt idler			
3. Rear beater belt			
4. Upper return elevator chain idler			
5.			
6.			

C. SEPARATOR

1. Separator check flap			
2. Grain pan front hangers			
3. Chaffer			
4. Chaffer extension			
5. Lower sieve			
6. Rear hanger bushings			
7. Grain pan shaker pitman			
8. Pan			
9. Tail gate deflector			
10. Bin elevator chain			
11. Bin elevator chain oiler			
12. Grain bin auger belt idler			
13.			

JOB SHEET #1

III. LUBRICATION

11. LUBRICATION		APPROVED LUBRICANT	HOW MUCH LUBRICANT	HOW OFTEN TO LUBRICATE
A. PLATFORM				
1.	Pitman			
2.	Auger bearings			
3.	Reel bearings			
4.	Platform lift brackets			
5.	Feeder chain idler			
6.	Feeder chain drive shaft bearings			
7.				
B. THRESHER				
1.	Front beater shaft bearings			
2.	Cylinder shaft bearings			
3.	Rear beater idler			
4.	Rear beater shaft bearings			
5.	Upper elevator bearings			
6.	Lower elevator bearings			
7.	Chain idler bearing			
8.	Upper auger bearings			
9.	Lower idler bearings			
10.				
C. SEPARATOR				
1.	Grain pan front hangers			
2.	Straw walker crank bearings			
3.	Rear hanger bearings			
4.	Grain pan shaker bearings			
5.	Fan shaft bearings			
6.	Straw spreader belt idler bearings			
7.	Straw spreader bearing			
8.	Upper bin elevator bearings			
9.	Grain bin auger bearings			
10.				
D. DRIVE				
1.	Wheel bearings			
2.	Brakes			
3.	U joints			
4.	Drive shafts			
5.	Variable speed			
6.	Differential			
7.				
8.				

Total Student Hours To Recondition Machine

COMBINE OPERATION AND MAINTENANCE
UNIT XIII

TEST

1. Match the terms on the right to the proper definition.

- | | |
|---|-------------------------------|
| _____ a. Combine supported by a fixed drive axle. | 1. Pick-up reel |
| _____ b. Combine is supported by pivoting axles. | 2. Level-land combine |
| _____ c. 3 to 8 slots made of wood or steel | 3. Bat type or slot-type reel |
| _____ d. Has several steel tines or fingers attached to the slots | 4. Hillside combine |
| _____ e. Combine is drawn by a tractor | 5. Pull-type combine |

2. List the five jobs a combine performs

- a.
- b.
- c.
- d.
- e.

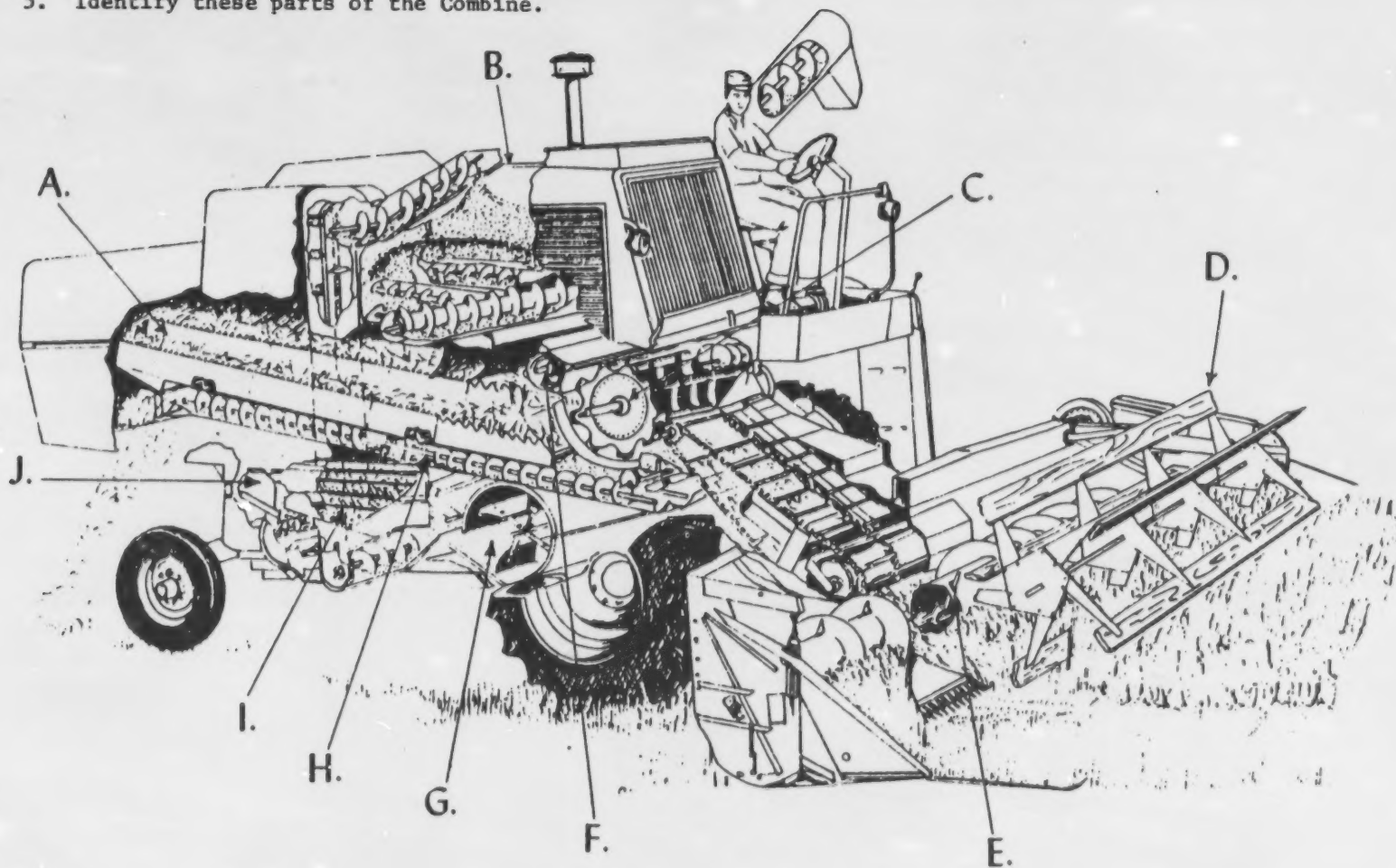
3. Match probable cause with trouble one may have

- | Trouble | Cause (May be used more than once) |
|-------------------------------|------------------------------------|
| _____ a. High cutterbar loss | 1. Low cylinder speed |
| _____ b. High cylinder loss | 2. Crop throwing out grain |
| _____ c. High reels loss | 3. Reel throwing out grain |
| _____ d. High sieve loss | 4. Overloading |
| _____ e. Cracked grain | 5. Shoe speed too high |
| _____ f. Cylinder wrapping | 6. High cylinder speed |
| _____ g. Poorly cleaned grain | 7. Loose elevator chains |
| | 8. Heavy growth of weeds |
| | 9. Reel shattering grain |
| | 10. Rack openings plugged |
| | 11. Too much wind blast |
| | 12. Sieve open too much |

4. List four factors which affect combine harvesting.

- a.
- b.
- c.
- d.

5. Identify these parts of the Combine.



E.

F.

G.

H.

I.

J.

COMBINE OPERATION AND MAINTENANCE
UNIT XIII

ANSWERS TO TEST

1.
 - a. 2
 - b. 4
 - c. 3
 - d. 1
 - e. 5

2.
 - a. Separating
 - b. Cleaning
 - c. Handling
 - d. Cutting and feeding
 - e. Threshing

3.
 - a. 3,9
 - b. 2,1
 - c. 4,10
 - d. 5,11
 - e. 6,7
 - f. 8
 - g. 12

4. Any four of the following:
 - a. Skill of the operator
 - b. Condition of the crop and field
 - c. Adjustment of the combine
 - d. Proper operating speed of harvesting components
 - e. Ground speed of the combine
 - f. Width of the header

5.

a. Straw Walker	f. Beater
b. Bine	g. Fan
c. Cylinder	h. Grain Pan
d. Reel	i. Sieves
e. Feeder Beater	j. Shoe

BALER OPERATION AND MAINTENANCE
UNIT XII

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to follow basic safety procedures associated with baler operation and maintenance. The student should be able to lubricate, operate, and make basic field adjustments. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hay balers.
2. List four safety precautions associated with baler operation.
3. Identify the parts of a round baler.
4. Identify the parts of a square baler.
5. List proper time to lubricate a baler at the proper intervals.
6. Describe the basic operation of a round baler.
7. Describe the basic operation of a square baler.

BALER OPERATION AND MAINTENANCE
UNIT XII

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with objective sheet
2. Provide students with information sheets
3. Make transparencies
4. Give test

Student:

1. Read objectives
2. Study information sheet
3. Take test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information sheet
3. Transparency masters
TM 1--Round Baler Parts
TM 2--Square Baler Parts
4. Test
5. Answer to test

References:

1. Roto Baler Operator's Manual, Allis Chalmers Corp.

2. New Holland Operator's Manual (Baler) New Holland, Div. Sperryland, New Holland, Pennsylvania 17557.
3. International Harvester Baler Service Manual, International Harvester Corp. Chicago, Illinois 60611.
4. John Deere Operator's Manual, John Deere Corp.

BALER OPERATION AND MAINTENANCE
UNIT XII

INFORMATION SHEET

I. Terms and Definitions

- A. Baler--A machine used to compress hay into square or round bales using wire or twine to hold them together
- B. Wire Twister--The mechanism on a square baler which twists twine around a bale
- C. Twine knotter--The mechanism on a square baler which ties twine around a bale
- D. Pickup--Part of a baler which picks the hay up off the ground
- E. Shear bolt--Small steel bolts placed on the flywheel, packer fingers, and needle mechanisms which shear under heavy load or when a malfunction occurs to stop power transfer
- F. Bale Chamber--Part of baler where the hay is compressed into bales
- G. Needle--Part of baler which places the twine or wire in position for tying mechanism
- H. Packerfinger--Part of square baler which packs hay into bale chamber
- I. Press Rolls--Rollers on a round baler which are flat belts driven which press and roll the hay into a cylindrical shape

II. Safety Precautions

- A. Don't clean, lubricate, or make adjustments on baler while it is in motion
- B. Don't engage clutch until you are certain that everyone is clear of machine
- C. Don't work around baler in loose clothing
- D. Don't try to pull loose hay from any part of baler while in operation
- E. Don't operate baler without all shields in place

III. Parts of round baler (AC) (Transparency 1)

- A. Raddle Assembly
- B. Right and left shoes

- C. Feed Roll
- D. Lower Drive Roll
- E. Press Roll
- F. Drive Chain
- G. Raddle Drive
- H. Conveyor Balance Spring
- I. Twine Needle Assembly

IV. Parts of square baler (Transparency 2)

- A. Engine or PTO Power Shaft
- B. Jack Stand
- C. Flywheel
- D. Knotters
- E. Bale Measuring Wheel
- F. Hydraulic Cylinder
- G. Bale Shute
- H. Feeder (Packer)
- I. Auger
- J. Auger
- K. Pickup
- L. Gauge Wheel
- M. Pickup Lift Lever

V. Proper Baler Lubrication

- A. Square Baler every 1000 bales (2 1/2 hours of operation under safety conditions)
- B. Round Baler Daily
- C. Time mechanism, needle, and plunger may require special attention

VI. Round Baler Operation

(NOTE: Double or tripler windrow for better bales. Make windrows 3 1/2 - 4 1/2 feet wide.)

- A. Hay is picked up by conveyor

- B. Hay passes under press roll onto lower band
- C. The lower bands pull it into the ball chamber
- D. The bands travel in opposite direction, so the hay is folded over and rolling starts
- E. Increasing diameter of bale pulls tension rolls close together and causes trip rolls to move outward
- F. This action causes mechanism to stop the conveyor, which signals the operator to stop forward movement
- G. Twine is released to be wrapped around bale with the last of the hay
- H. The twine is cut and the trip rolls open ejecting the bale
- I. All mechanisms return to original position and conveyor begins, signaling operator to move forward

(NOTE: For threading of twine, size of bale and other basic information see operator's manual.)

VII. Square Baler Operation and Adjustment

A. Operation

- 1. Pickup moves hay up to the auger or gathering tines in some models
- 2. Auger or tines move hay to ball chamber
(NOTE: Auger with packer finger and tines have adjustment on them in order to adjust feed according to varied hay conditions. These devices can make difference between even and oblong bales.)
- 3. Plunger packs and pushes hay through bale chamber
- 4. Bale length is measured by wheel measuring device which trips and starts knotter mechanism

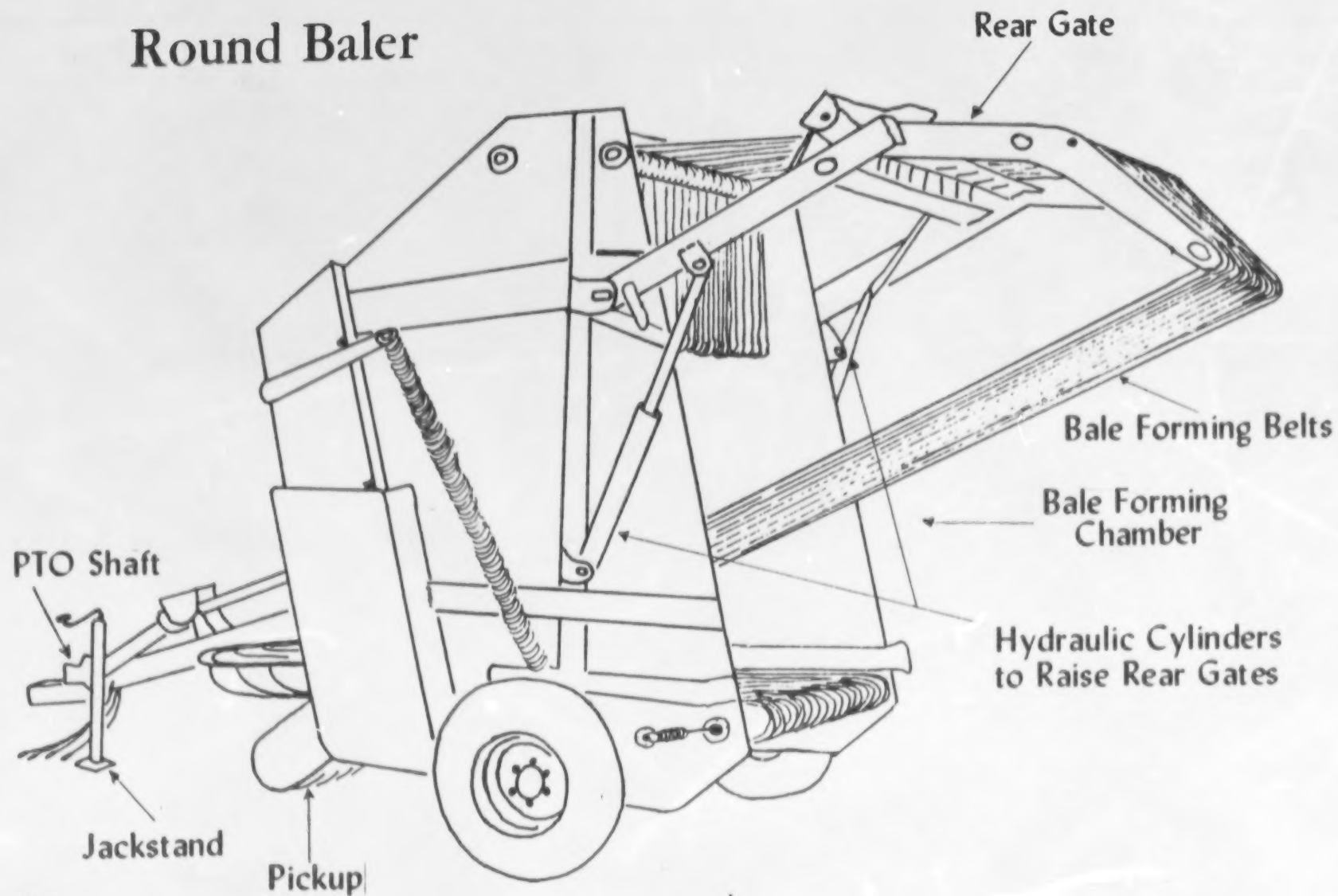
B. Adjustment--according to operator's manual

- 1. Gauge wheel
- 2. Sharpening and adjusting bale chamber knives
- 3. Adjust bale chamber play
- 4. Adjust packer finger (feeder)
- 5. Set flywheel clutch spring pressure
(NOTE: Winter storage pressure should be released from clutch)
- 6. Adjust bale weight
(NOTE: By hydraulic pressure mechanism, manual screw, bale chamber wedges, and bale length.)

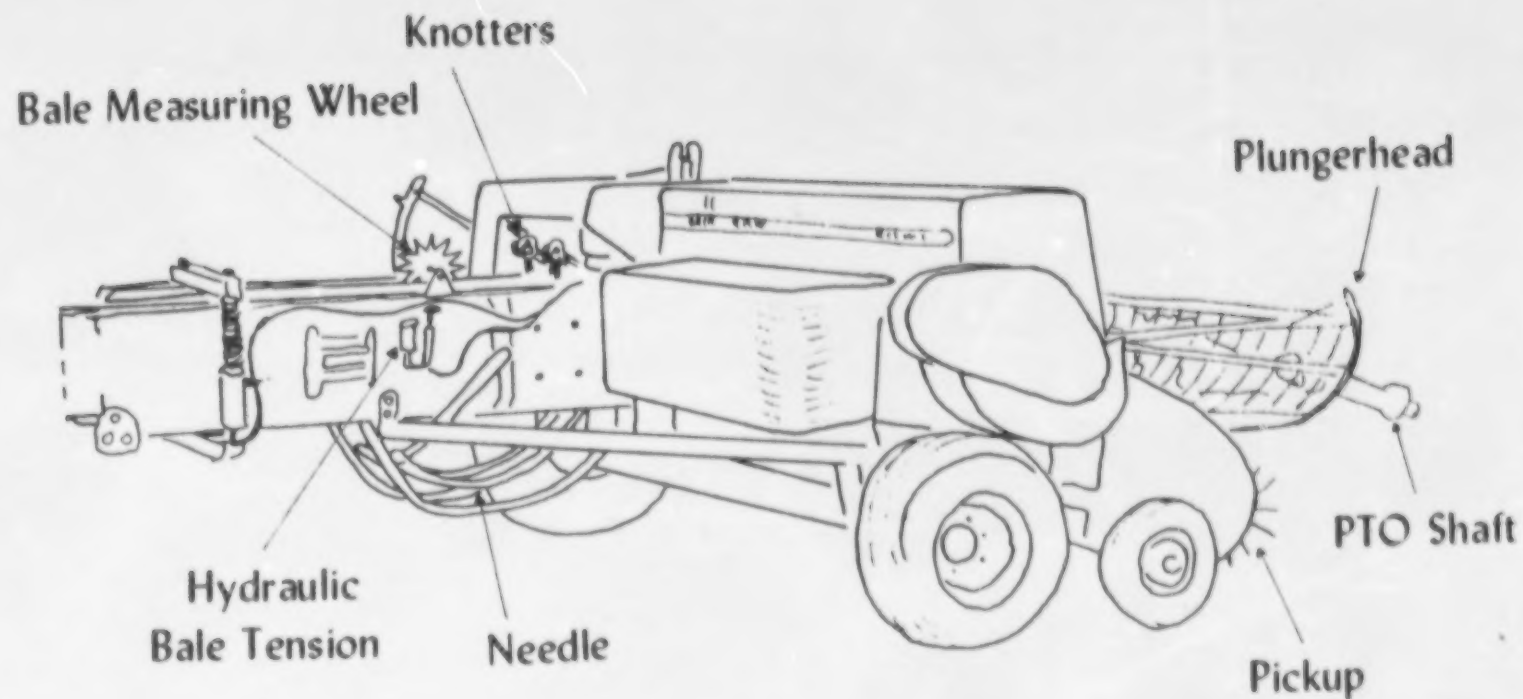
7. Obtain manufactures trouble shooting service manual for baler and become familiar with the knotter or twister operation and timing

(NOTE: Always keep bale chamber stop lubricated and functionable. If it doesn't work and baler timing slips, then the plunger will bale up needles in bale chamber because stop will not cause shear bolts to break.)

Round Baler



Square Baler



BALER OPERATION AND MAINTENANCE
UNIT XII

TEST

1. Match the following terms with the proper definition and place the correct number in the blank.

- | | |
|--------------------------------|---|
| a. _____ Needle | 1. Roller on a round baler which is flat belt driven which flattens the hay. |
| b. _____ Baler | 2. Mechanism on a square baler which knots twine |
| c. _____ Pickup | 3. Part of a baler which places the wire in position for the twister. |
| d. _____ Press roll | 4. Part of square bale which picks hay into bale chamber. |
| e. _____ Packerfinger (feeder) | 5. A machine used to compress hay into square or round bales using wire or twine to hold them together. |
| | 6. Part of baler which gathers the hay out of the windrow. |

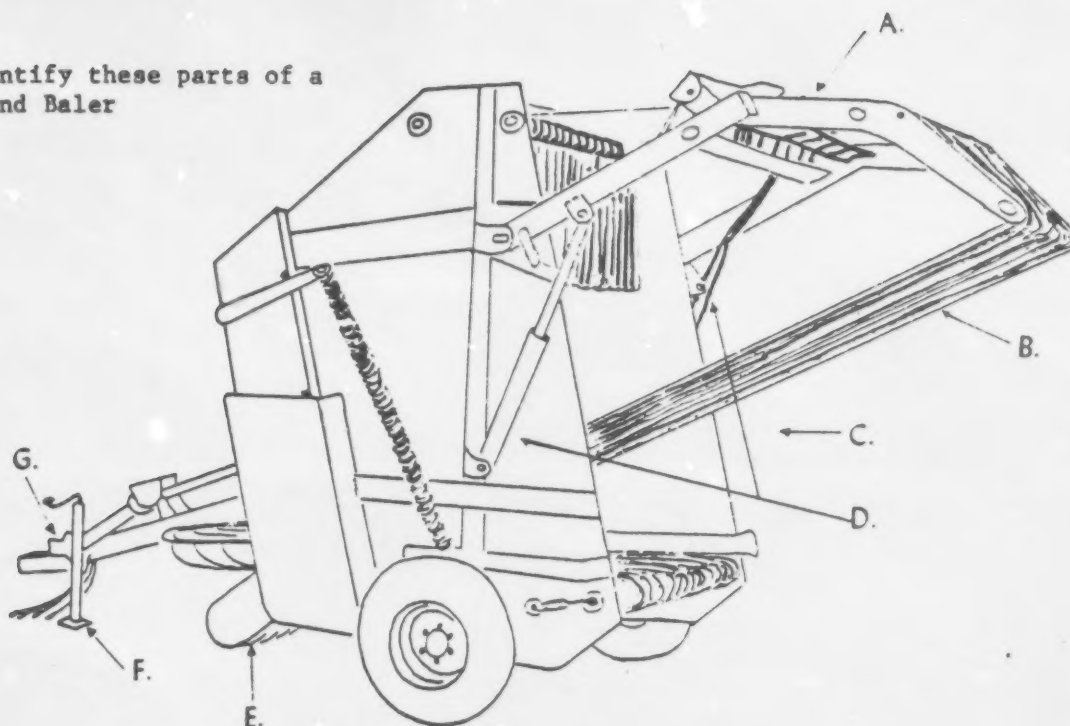
2. List four safety precautions associated with balers.

- a.
b.
c.
d.

3. One should lubricate a square baler every _____ bales and a round baler after _____ day (s).
4. Describe the operation of a round baler.

5. Describe the operation of a square baler.

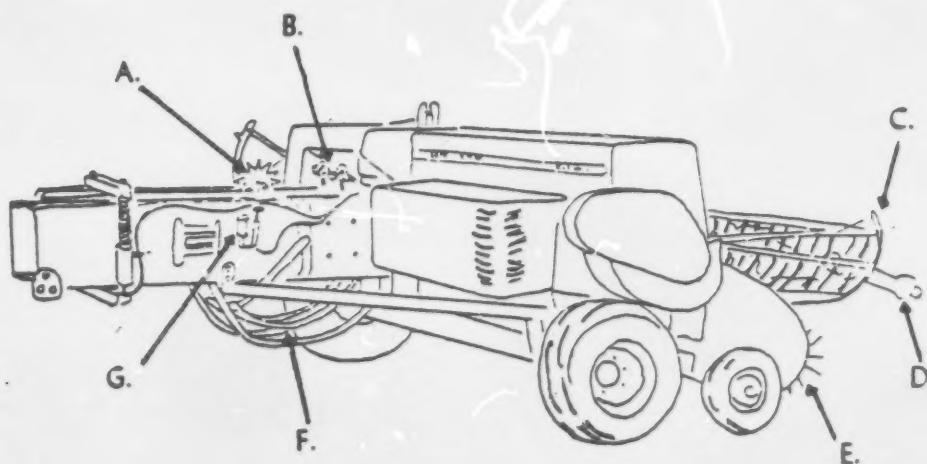
6. Identify these parts of a Round Baler



A. _____
 B. _____
 C. _____
 D. _____

E. _____
 F. _____
 G. _____

7. Identify these parts of a Square Baler.



A. _____
 B. _____
 C. _____
 D. _____

E. _____
 F. _____
 G. _____

BALER OPERATION AND MAINTENANCE
UNIT XII

ANSWERS TO TEST

1. a. 3
b. 5
c. 6
d. 1
e. 4
2. Any four below:
 - a. Don't engage clutch until you are certain that everyone is clear of machine.
 - b. Don't clean, lubricate, or make adjustments on baler while it is in motion.
 - c. Don't work around baler in loose clothing.
 - d. Don't try to pull loose hay from any part of baler while in operation.
 - e. Don't operate baler without all shields in place.
3. 1000 Bales
1 day
4. Written information should include:
Pick-up operation
Press Roll
Lower band
How hay is folded together
How conveyor is stopped and needle is tripped
5. Written information should include:
Pick-up operation
Auger Function
Plunger Function
Bale length measurement
6. a. Rear Gate
b. Bale Forming Belts
c. Bale Forming Chamber
d. Hydraulic Cylinders to Raise Rear Gates
e. Pickup
f. Jackstand
g. PTO Shaft

7. a. Bale Measuring Wheel
- b. Knotters
- c. Plungerhead
- d. PTO Haft
- e. Pickup
- f. Needle
- g. Hydraulic Bale Tension

INTRODUCTION TO PLUMBING
UNIT VII

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to identify pipe and pipe fittings. He should be able to demonstrate the proper procedures for threading, reaming, and cutting pipe. These skills should be adapted to his home, farm, and community. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define five terms associated with plumbing.
2. Name and give the use of five different kinds of pipe.
3. Identify ten common pipe fittings.
4. List two reasons for using threading compounds.
5. Identify five tools used in plumbing.
6. Name four reasons for using cutting oil.
7. Indicate in writing five common sizes of pipe used in plumbing.
8. Distinguish between bolt and pipe threads.
9. Indicate in writing how pipe and bolts are measured in order to determine diameter.
10. Determine pipe length and thread length.
11. Demonstrate the proper procedures for performing the following jobs:
 - a. Cutting pipe
 - b. Reaming pipe
 - c. Threading pipe

INTRODUCTION TO PLUMBING
UNIT VII.

SUGGESTED ACTIVITIES

- I. Instructor
 - A. Provide students with objective sheet
 - B. Provide students with information and job sheets
 - C. Make transparencies
 - D. Discuss terminal and specific objectives
 - E. Discuss information sheet
 - F. Demonstrate and discuss procedures outlined in the job sheets
 - G. Give test
- II. Students
 - A. Read objective sheet
 - B. Study information sheet
 - C. Demonstrate the ability to accomplish the procedures outlined in the job sheets
 - D. Take test

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objectives
 - B. Information sheet
 - C. Transparency masters
 - TM 1--Pipe Fittings
 - TM 2--Plumbing Tools
 - TM 3--Types of Valves
 - TM 4--Measuring for Pipe Length
 - D. Assignment sheet #1--Determining Pipe and Thread Length
 - E. Answers to assignment sheet
 - F. Job sheets
 - #1--Cutting Pipe
 - #2--Reaming Pipe
 - #3--Threading Pipe
 - G. Test

H. Answers to test

II. References:

- A. Farm Mechanics Text and Handbook, Lloyd J. Phipps, H.F. McColly, L.L. Scranton, and G.C. Cook, Interstate Printers and Publishers, Danville, Illinois.
- B. Shopwork on the Farm, M.M. Jones, McGraw-Hill Book Company, New York, New York.
- C. General Shop Guide for Vo-Ag Students, State of Alabama, State Department of Education, Vocational Division, Agricultural Education Service, Montgomery, Alabama.
- D. The Farm Shop, Wakeman & McCoy, MacMillan Co., New York, New York.

INTRODUCTION TO PLUMBING
UNIT VII

INFORMATION SHEET

I. Terms and definitions

- A. Plumbing - The piping and pipe attachments used to carry water into buildings and to drain away sewage and waste
- B. Soil pipes - The large pipes used to carry sewage
- C. Fittings - The pieces used to join pipe, to provide openings in pipes, and to change the direction of pipes
- D. Trap - A water-sealed bend or chamber in a waste pipe
- E. House drain - A pipe which carries all the sewage from the house
- F. Stack - A soil, waste, or ventilating pipe
- G. Fixtures - The appliances connected to the plumbing
- H. Septic tank - A tank which receives all the sewage piped into it and allows the process of sewage treatment to take place
- I. Lateral pipe - A pipe which drains the liquid from the septic tank to the soil

II. Kinds of pipe

- A. Black - Used for natural and L.P. gas, oil, and air lines
- B. Galvanized - Used for water lines
- C. Copper tubing - Used in water, refrigeration, and waste systems
- D. Cast iron - Used in sewage systems
- E. Brass or lead - Used for traps and drains
- F. Plastic - Used in water systems
- G. PVC - Used in a water or sewage system (plastic pipe)
- H. Soil - Used in a sewage system (cast iron pipe)

III. Pipe fittings (Transparencies 1 and 3)

- A. Elbow
- B. Street elbow
- C. Reducer

- D. Coupling
- E. Nipple
- F. Tee
- G. Union
- H. Bushing
- I. Cap
- J. Plug
- K. Floor flange
- L. Cross
- M. "Y"
- N. Globe valve
- O. Gate valve
- P. Gas stop

IV. Reasons for using threading compounds

- A. Insures tight joints
- B. Prevents threads from rusting

V. Tools used in plumbing (Transparency 2)

- A. Stock and die
- B. Pipe vise
- C. Reamer
- D. Pipe wrench
- E. Pipe cutter
- F. Hack saw
- G. Taper triangular file

VI. Reasons for using cutting oil on tools

- A. Cuts smoother
- B. Cuts easier
- C. Lasts longer
- D. Removes burrs from dies

VII. Common sizes of pipe used in plumbing

- A. 1/4"
- B. 1/2"
- C. 3/4"
- D. 1"
- E. 1 1/4"

VIII. Threads

- A. Pipe - Tapered 1/16" per inch
(NOTE: Pipe has standard threads.)
- B. Bolt - Straight threads
 - 1. National coarse
 - 2. National fine

IX. Diameter measurements

- A. Pipe - Inside
- B. Bolt - Outside

X. Estimating and measuring pipe length

(NOTE: It is necessary to make allowances for threads and for fitting projections when measuring for threaded pipes.)

A. Pipe replacements

- 1. Measure the distance from face of one fitting to face of other fitting (Transparency 4)
- 2. Add the length of pipe that will enter the fitting at each end
(NOTE: The length of the thread for each end of the pipe should be determined from the Supplemental Information. The amount of thread cut on a pipe varies as to size of pipe. Since pipe threads are tapered, this has an effect upon how far the thread enters the fitting.)

B. New pipe installations

- 1. Measure the distance from center line of one fitting to center line of other fitting (Transparency 4)
- 2. Determine the amount of pipe needed to go into the fittings at each end of pipe (See Supplemental Information)
- 3. Determine the distance from center line of the fitting to the face for each fitting (Transparency 4)
(NOTE: Center to face distance varies according to the type of fitting; example: elbow, straight tee, union)
- 4. The length of new pipe = center to center distance + amount needed to go into fittings at each end - center to face of fitting distances

SUPPLEMENTAL INFORMATION

STANDARD MALLEABLE FITTINGS

Nominal Size (in.)	General Dimensions (inches)					
	A	B	C	D	E	F
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	—	1	$\frac{1}{8}$
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	1	$1\frac{1}{8}$	$\frac{1}{4}$
$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$\frac{3}{8}$
$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{8}$
1	$\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$2\frac{1}{8}$	$1\frac{1}{2}$
$1\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{1}{2}$
$1\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{1}{2}$
2	$2\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$3\frac{1}{8}$	$2\frac{1}{8}$
$2\frac{1}{2}$	$2\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{1}{8}$	$3\frac{1}{8}$	$3\frac{1}{8}$	—
3	$3\frac{1}{8}$	$2\frac{1}{8}$	$3\frac{1}{8}$	$3\frac{1}{8}$	$4\frac{1}{8}$	—

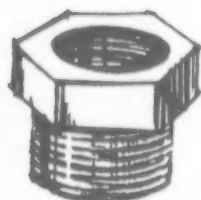
STEEL AND WROUGHT - IRON PIPE DATA*

Nom. Outside Pipe Size	Diam.	Standard		Extra Strong		Threads Per Inch	Tap Drill Size	Hole Size "	Length of Thread	Dist. Pipe Goes into fitting
		Inside Diam.	Weight Lb. Per Ft.	Inside Diam.	Weight Lb. Per Ft.					
$\frac{1}{8}$	0.405	0.269	0.24	0.215	0.31	27	$\frac{1}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
$\frac{1}{4}$	0.540	0.364	0.42	0.302	0.53	18	$\frac{7}{32}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
$\frac{3}{8}$	0.675	0.493	0.57	0.423	0.74	18	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{2}$
$\frac{1}{2}$	0.840	0.622	0.85	0.546	1.09	14	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{2}$
$\frac{5}{8}$	1.050	0.824	1.13	0.742	1.47	14	$\frac{1}{8}$	$1\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
1	1.315	1.049	1.68	0.957	2.17	$11\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$
$1\frac{1}{4}$	1.660	1.380	2.27	1.278	3.00	$11\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$
$1\frac{1}{2}$	1.900	1.610	2.72	1.500	3.63	$11\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$
2	2.375	2.067	3.65	1.937	5.04	$11\frac{1}{2}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$
$2\frac{1}{2}$	2.875	2.469	5.79	2.323	7.66	8	$2\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$
3	3.500	3.068	7.58	2.900	10.25	8	$3\frac{1}{8}$	$3\frac{1}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$

*All measurements are stated in fractional or decimal inches.

**Size of hole to drill to insert pipe through walls, floors, and other materials.

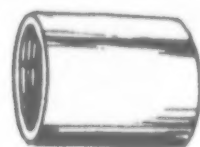
Pipe Fittings



Bushing



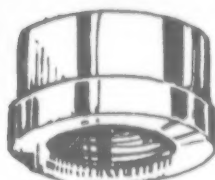
90° Elbow



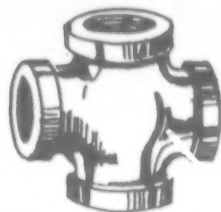
Coupling



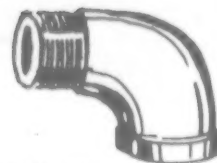
Bell Reducer



Cap



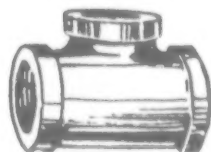
Straight Cross



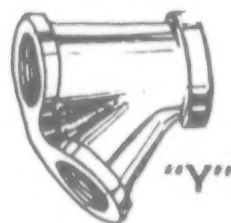
90° Street Elbow



Plug



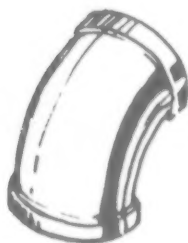
Straight Tee



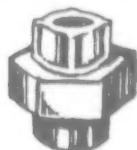
"Y"



Nipples



45° Elbow



Union



Floor Flange

Plumbing Tools



3-Way Pipe Threaders



Small Ratchet Threaders



Bench Yoke Vises



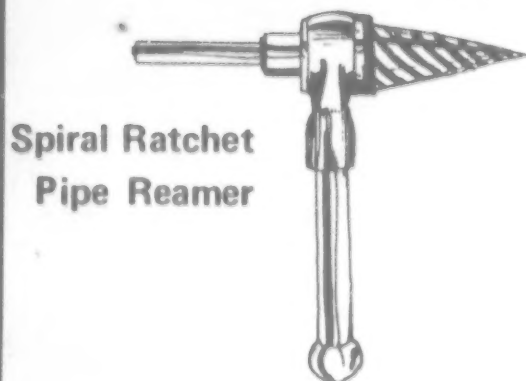
Pipe Cutter



Burr Reamer



Chain Vises



Spiral Ratchet
Pipe Reamer

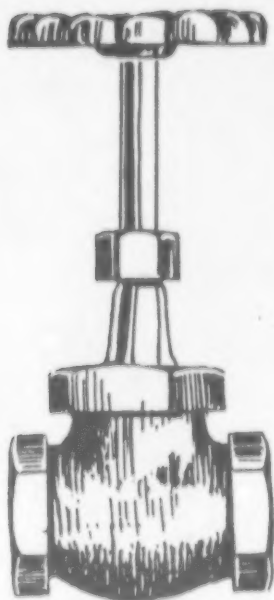


Pipe Wrench

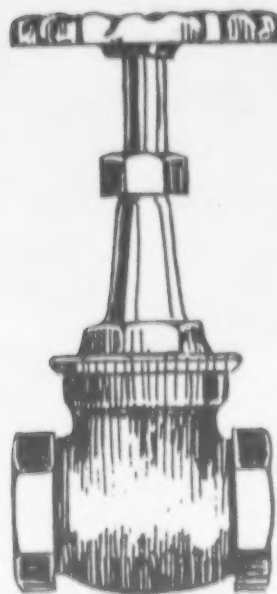


Die

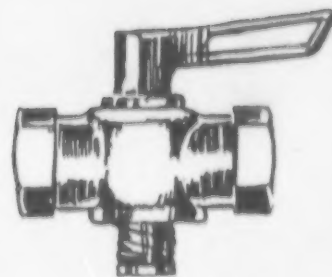
Types of Valves



Globe Valve

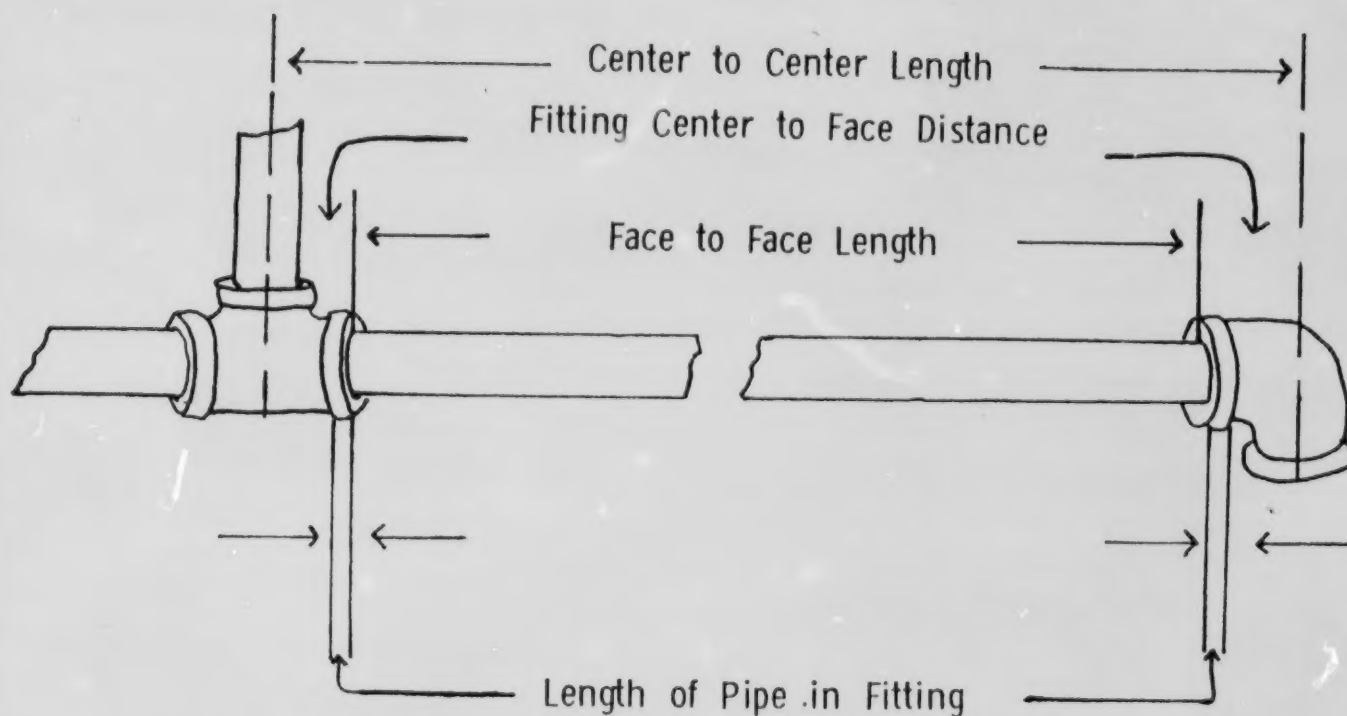


Gate Valve



Gas Stop

MEASURING FOR PIPE LENGTH

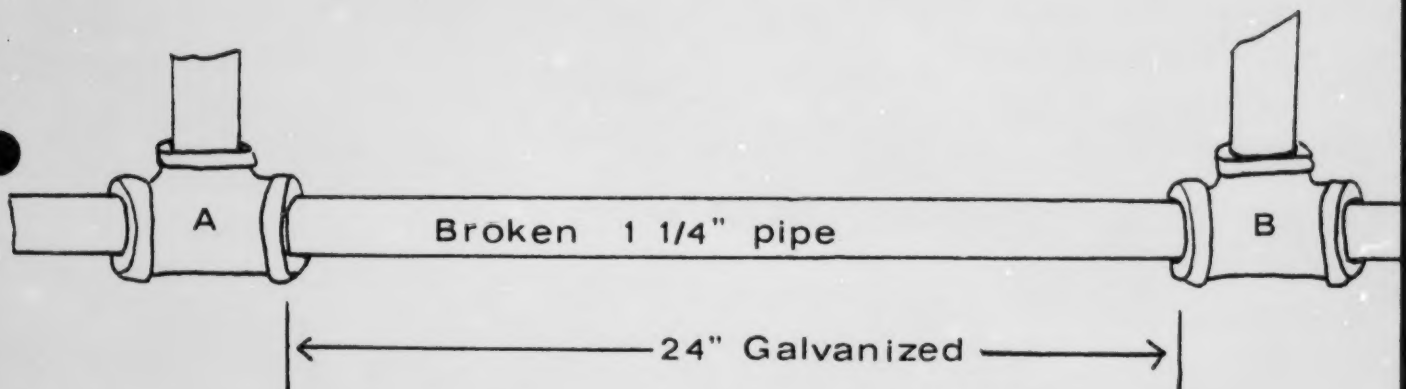


INTRODUCTION TO PLUMBING
UNIT VII

ASSIGNMENT SHEET #1--DETERMINING PIPE AND THREAD LENGTH

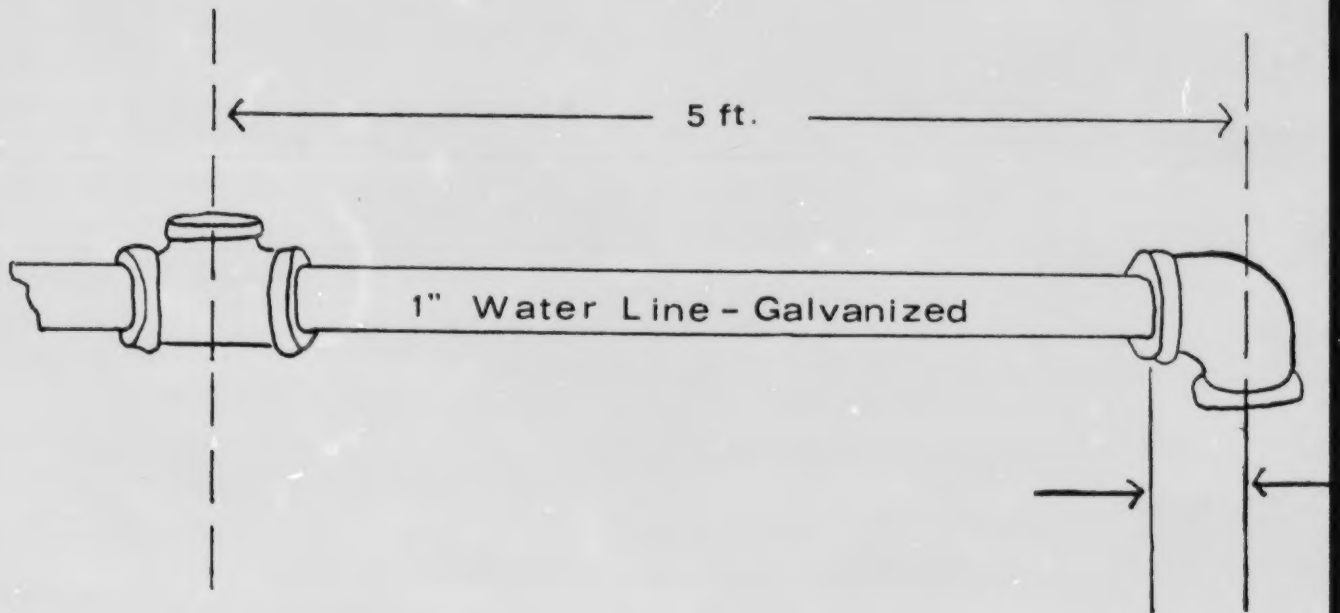
Determine the length of the piece of pipe needed in the following situations. Determine the following measurements required for replacing the broken pipe in the figure below.

1. How long a pipe will be needed to replace the broken one in the sketch below? How long a thread is needed?



- a. Face to face length = _____
- b. Length of inside fittings for A & B = _____
- c. Total length needed = _____
- d. Thread length = _____

2. How long a pipe will be needed to install the new water supply line shown in the sketch below? How long a thread?

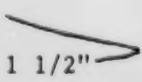


- a. Center to center distance = _____
- b. Center to face distance - Elbow = _____
- Straight Tee = _____
Total = _____
- c. Face to face length = _____
- d. Inside fitting length = _____
- e. Total length needed = _____
- f. Thread length = _____

INTRODUCTION TO PLUMBING
UNIT VII

ANSWERS TO ASSIGNMENT SHEET #1

1. Face to face length = 24"
Length inside A & B - A = $5/8"$, B = $5/8"$, Total = $1\ 1/4"$
Total length = $25\ 1/4"$
Thread length = $1\ 1/16"$

2. Center to center distance = 60"
Center to face of elbow = $1\ 1/2"$
Center to face of straight tee = $1\ 1/2"$  Total = 3"
Face to face length = 57"
Inside fitting length = $9/16" \times 2" = 1\ 1/8"$
Total length needed = $58\ 1/8"$
Thread length = $1\ 1/32"$

INTRODUCTION TO PLUMBING
UNIT VII

JOB SHEET #1--CUTTING PIPE

Demonstrate your ability to cut pipe according to the instructions and procedures given. Cut two pieces of $3/4$ inch pipe eight inches long. Cut one piece of $1/2$ inch pipe eight inches long. Turn in to the instructor for a grade.

I. Tools needed

- A. Vise
- B. Taper triangular file
- C. Ruler or steel tape
- D. Pipe cutter

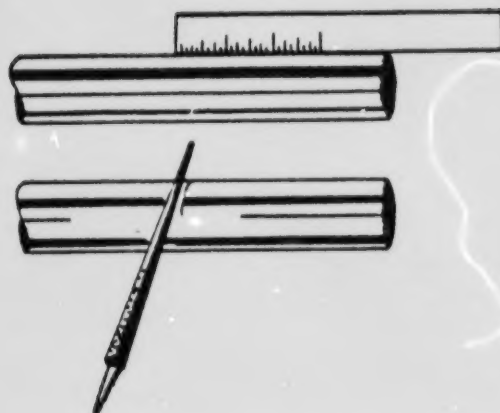
II. Materials needed

- A. Two feet of $3/4$ inch pipe
- B. One foot of $1/2$ inch pipe

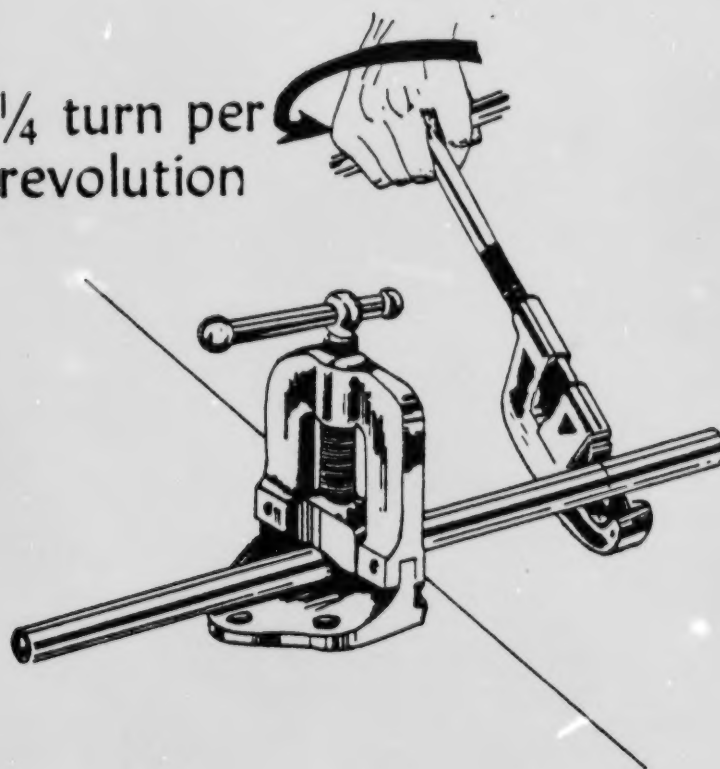
III. Procedures

- A. Measure length of pipe desired
- B. Mark desired length with tapered triangular file
- C. Fasten pipe in vise so mark is at least four inches from vise
- D. Place pipe cutter on mark
- E. Tighten pipe cutter by screwing in handle until cutting wheel is snug against pipe
- F. Hold handle perpendicular to the pipe and tighten handle until cutting wheel penetrates metal
- G. Turn pipe cutter $1/4$ turn per revolution until pipe is cut off
- H. Check cut for squareness

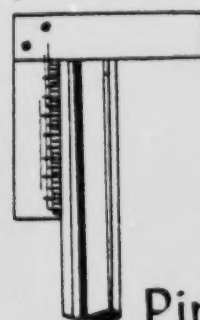
IV. Diagram of procedure



$\frac{1}{4}$ turn per
revolution



Tri-Square



Pipe

INTRODUCTION TO PLUMBING
UNIT VII

JOB SHEET #2--REAMING PIPE

Demonstrate your ability to ream pipe according to the instructions and procedures given. Ream two pieces of $3/4$ inch pipe eight inches long. Ream one piece of $1/2$ inch pipe eight inches long. Turn in to the instructor for a grade.

I. Tools needed

- A. Vise
- B. Burr reamer
- C. Carpenter brace

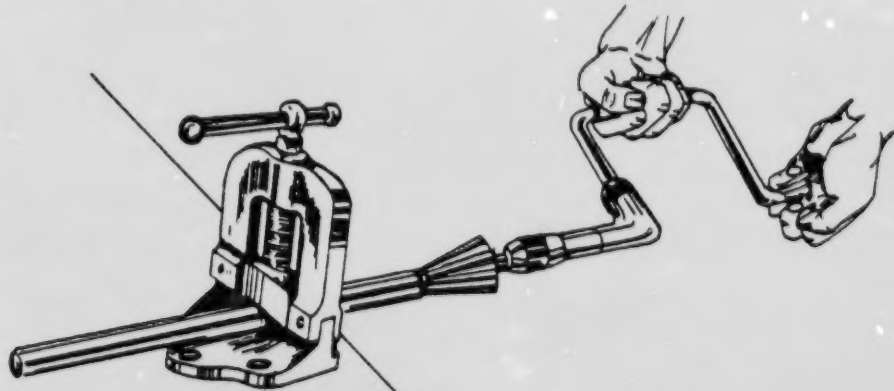
II. Materials needed

- A. Two pieces of $3/4$ inch pipe eight inches long
- B. One piece of $1/2$ inch pipe eight inches long

III. Procedures

- A. Fasten pipe in vise allowing four inches to extend from vise
- B. Place reamer in line with pipe
- C. Turn reamer clockwise until inside burr is off
- D. Remove reamer and check with finger to see if burr is cut away
(NOTE: Do not cut more than necessary as first threads on pipe will be weakened.)

IV. Diagram of procedure



INTRODUCTION TO PLUMBING
UNIT VII

JOB SHEET #3--THREADING PIPE

Demonstrate your ability to thread pipe according to the instructions and procedures given. Thread the pieces of pipe that were used in job sheets #1 and #2. Thread pipes on both ends and turn in to the instructor for grade.

I. Tools needed

- A. Vise
- B. Flat file
- C. 3/4" and 1/2" dies
- D. Die stock
- E. Cutting oil
- F. Wire brush

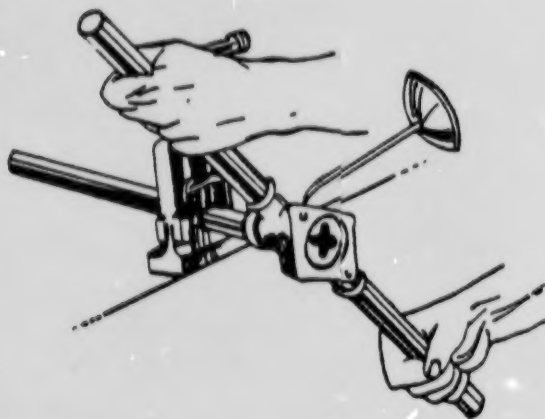
II. Materials needed

- A. Two pieces of 3/4 inch pipe eight inches long
- B. One piece of 1/2 inch pipe eight inches long

III. Procedures

- A. Place pipe in vise allowing six inches to extend from vise
- B. File off any outside burr that may be on pipe end caused by cutting pipe
- C. Place proper size die in stock
- D. Place pressure against die holder with palm of hand, turn clockwise until die starts cutting threads
- E. Use cutting oil on the threading area at all times
- F. Continue threading until one thread is past the die
- G. Back off die and inspect threads
- H. Use wire brush and clean thread

IV. Diagram of procedure



INTRODUCTION TO PLUMBING
UNIT VII

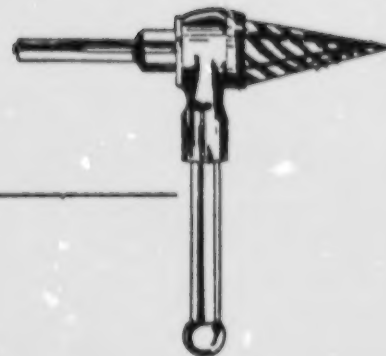
TEST

1. Define the following terms:
 - a. Trap -
 - b. House drain -
 - c. Plumbing -
 - d. Soil pipes -
 - e. Fittings -
2. Name five kinds of pipe and give one use of each.
 - a.
 - b.
 - c.
 - d.
 - e.
3. Name two reasons for using threading compounds.
 - a.
 - b.
4. Name four reasons for using cutting oil when threading pipe.
 - a.
 - b.
 - c.
 - d.

5. Identify the following tools:



a. _____



b. _____



c. _____



d. _____

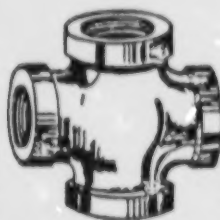


e. _____

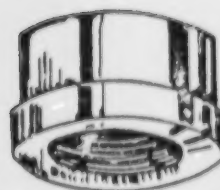
6. Identify the following pipe fittings:



a. _____



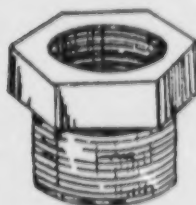
b. _____



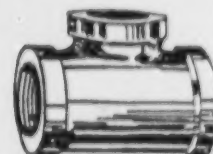
c. _____



d. _____



e. _____



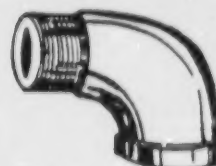
f. _____



g. _____



h. _____



i. _____



j. _____

7. What are five common sizes of pipe used in plumbing?
 - a.
 - b.
 - c.
 - d.
 - e.
8. How can you distinguish between bolt and pipe threads?
9. How is bolt size measured?
10. How is pipe size measured?
11. Performance tests will be conducted for the following:
 - a. Cutting pipe
 - b. Reaming pipe
 - c. Threading pipe

INTRODUCTION TO PLUMBING
UNIT VII

ANSWERS TO TEST

1.
 - a. Trap - A water-sealed bend or chamber in a waste pipe
 - b. House drain - A pipe which carries all the sewage from the house
 - c. Plumbing - The piping and pipe attachments used to carry water into buildings and to drain away sewage and waste
 - d. Soil pipes - Large pipes used to carry sewage
 - e. Fittings - Pieces used to join pipe, to provide openings in pipes, and to change the direction of pipes
2. Any five of the following:
 - a. Black - Used for natural and L.P. gas, oil, and air lines
 - b. Galvanized - Used for water lines
 - c. Copper tubing - Used in water, refrigeration, and waste systems
 - d. Cast iron - Used in sewage systems
 - e. Brass or lead - Used in traps and drains
 - f. Plastic - Used in water systems
 - g. PVC - Used in a water or sewage system (plastic pipe)
 - h. Soil - Used in a sewage system (cast iron pipe)
3.
 - a. Insures tight joints
 - b. Prevents threads from rusting
4.
 - a. Cuts easier
 - b. Cuts smoother
 - c. Lasts longer
 - d. Removes burrs from dies

- 5.
 - a. Bench vise
 - b. Ratchet pipe reamer
 - c. Pipe cutter
 - d. Ratchet threaders
 - e. 3-way pipe threader

- 6.
 - a. Coupling
 - b. Cross
 - c. Cap
 - d. 45° Elbow
 - e. Bushing
 - f. Tee
 - g. Union
 - h. Plug
 - i. Street elbow
 - j. Nipple

- 7.
 - a. 1/4"
 - b. 1/2"
 - c. 3/4"
 - d. 1"
 - e. 1 1/4"

- 8. Pipe threads are tapered 1/16" per inch; bolt threads are straight

- 9. Outside diameter

- 10. Inside diameter

ELECTRICAL SAFETY UNIT II

TERMINAL OBJECTIVE

After completion of Unit II, the student should be able to demonstrate safety practices in working with electricity to protect life and property. He should be able to recognize danger areas when surveying his home farm. This knowledge will be evidenced through demonstration and by scoring one hundred percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able

1. Write the definition of five terms dealing with electrical safety.
2. Name five sources of electrical defects in equipment.
3. Name the three major causes of electrical accidents.
4. Name three ways of freeing a person that is receiving an electrical shock.
5. Name six causes of electrical fires.
6. Discuss in a short paragraph the danger and damage caused by improperly using electricity and electrical equipment.
7. Discuss in a short paragraph the type of first aid that should be given to a person who has just received an electrical shock.
8. Match types of fires to the correct definition of each.
9. Select the proper fire extinguishers to use in controlling fire.
10. Select from a list of terms or statements the one that contributes to death due to electrical shock.
11. Name five sure signs that wiring is out-of-date.
12. Name the three reasons why circuits fail.
13. Identify four types of circuit protection devices.
14. Identify the three types of common fuses.
15. Survey your home farm for safe and unsafe electrical conditions.
16. Demonstrate the ability to use the National Electrical Code according to the "Official Interpretations" of the intent of the code.

ELECTRICAL SAFETY
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objectives.
- B. Provide students with information and assignment sheets and a copy of the NEC.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information and assignment sheets.
- F. Counsel with students about safe and unsafe working conditions of electricity. Prepare a list of safety rules.
- G. Provide students with information about electrical accidents using newspaper clippings.
- H. Demonstrate the procedures for using the National Electrical Code.
- I. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheets.
- C. Complete assignment sheets.
- D. Survey home farm for safe and unsafe electrical conditions.
- E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
 - 1. TM 1 - Electrical Circuits
 - 2. TM 2,3 - Safety Precautions
 - 3. TM 4 - Circuit Protection Devices
 - 4. TM 5 - Types of Common Fuses or Fusetrans
- D. Assignment sheets
 - 1. Assignment Sheet #1 - Survey Electrical Conditions on the Home Farm

- 2. Assignment Sheet #2 - Use the National Electrical Code
- E. Answers to Assignment Sheet #2
- F. Test
- G. Answers to test

II. References:

- A. Simplified Electric Wiring Handbook, Sears-Roebuck and Company, Chicago, Illinois.
- B. Brown, Robert H. Farm Electrification. New York: McGraw-Hill Book Company, Inc.
- C. Phipps, Lloyd J., H.F. McColly, L.L. Scranton, and G.C. Cook. Farm Mechanics Text and Handbook. Danville, Illinois: The Interstate Printers and Publishers, Inc.
- D. Farm Electricity, State of Tennessee, Department of Education, Division of Vocational Education.
- E. Basic Electricity and Practical Wiring Lessons, The Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.
- F. Recht, J.L. Accident Facts. Chicago, Illinois: National Safety Council.
- G. National Electrical Code. Boston, Massachusetts: National Fire Protection Association.
- H. Richter, H.P. Wiring Simplified, St. Paul, Minnesota: Park Publishing, Inc.
- I. Ekart, Delbert. Can A 110 Volt Shock Be Fatal? Kansas Farm Bureau Safety Department, Manhattan, Kansas
- J. Safe Use of Electricity. Cooperative Extension Service, Kansas State University, Manhattan, Kansas XE-E29

ELECTRICAL SAFETY
UNIT II

INFORMATION SHEET

I. Terms and definitions

- A. Fuse - A safety device which breaks the flow of electrical current when a circuit becomes overloaded
(NOTE: A fuse must be replaced when blown.)
- B. National Electric Code - A written statement that sets minimum standards for wiring and materials.
- C. Test lamp - A tool used in checking short circuits, hot lines, and voltages
- D. Fusetron - A double element time delay fuse designed to withstand momentary overloads
- E. Grounding conductor - A green or bare wire which serves as the third wire on 115 volt appliances to provide an easy path for electricity to flow from a hot or shorted piece of equipment to the ground, causing the breaker to throw
- F. Closed Circuit - A completed path through which electricity flows (Transparency 1)
- G. Open Circuit - An uncompleted path which does not permit the flow of electricity
- H. Circuit breaker - A safety device which breaks the flow of electrical current when a circuit becomes overloaded.
(NOTE: A circuit breaker may be reset.)
- I. Ground Fault Circuit Interrupter (GFCI) - A device that senses any current difference in the two wires of a circuit and disconnects the circuit if the difference exceeds 5 milliamperes.

II. Electrical defects in equipment

- A. Ground wire missing, broken, improperly connected, or not connected at all
- B. Open conduits; switch boxes damaged or worn
- C. Worn, wet, or oily insulation causing short circuits
- D. Defective switches, receptacles, extension or lamp cords, and lamp sockets
(CAUTION: When handling lamp socket, keep bulb intact.)
- E. Dirty, improperly adjusted electrical equipment.
- F. Loose vibrating machine parts which might cause a short circuit

III. Major causes of electrical accidents

- A. Carelessness
- B. Misuse
- C. Equipment Failure

IV. Freeing a person - Electrical Shock (Transparency 2)

(NOTE: 120-240 volt)

- A. Locate "line wire" or source of electrical current and disconnect
(CAUTION: Do not take hold of the person's body with your bare hand.)
- B. Decide immediately whether it would be easier to move the person or move the conductor
(CAUTION: If conductor is to be moved, use dry stick, if person's body is to be moved, use several thicknesses of paper or cloth as an insulator.)
- C. With paper or cloth in hand, grasp the person's arm or leg and quickly pull him free of the conductor
- D. Over 240 volts
(CAUTION: If you see a downed wire, assume it is "hot" and can kill you. Protect the scene by posting a guard to keep passerby at least 200 feet away, then immediately call your power supplier to give them the exact location of the trouble.)

Phone _____

V. Causes of electrical fires

- A. Makeshift wiring
- B. Overload wiring
- C. Improper fusing
- D. Neglected maintenance
- E. Exposed lamp bulbs near flammable materials
- F. Improper grounding

VI. Electrical danger and damage

(NOTE: Figures are from the years 1974-76 as compiled by the National Safety Council.)

- A. 1,041 persons killed in 1976
- B. Contributes to 3 to 4 percent of all accidental deaths
- C. Destroyed \$253,300,000 worth of property in 1974
(NOTE: Fixed services, fires due to wiring and equipment.)
- D. Destroyed \$110,200,000 worth of appliances in 1974

(NOTE: Power consuming appliances.)

(NOTE: Figures on electrical damage not available from NSC after 1974.)

VII. Proper first aid

- A. Call doctor or ambulance immediately
- B. Only treatment is mouth-to-mouth resuscitation

(NOTE: First aid includes treatment for shock)

VIII. Types of fires

- A. Class A - Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish
- B. Class B - Fires that occur with flammable liquids, such as gasoline, oil, grease, paints, and thinners
- C. Class C - Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring

IX. Types of fire extinguishers

- A. Pressurized water - Operates usually by squeezing a handle or trigger; used on Class A fires
- B. Soda acid - Operates by turning extinguisher upside down; used on Class A fires
- C. Carbon dioxide (CO₂) - Operates usually by squeezing a handle or trigger; used on Class B fires
- D. Dry chemical - Operates usually by squeezing a handle, trigger, or lever; used on Class B or C fires
- E. Foam - Operates by turning extinguisher upside down; used on Class A and B fires

X. Electrical death

- A. Current kills, not voltage
- B. Voltage is involved
- C. Example - Less than 1/4 ampere will stop the heart

(NOTE: Current flowing in a 25-watt lamp at 115 volts is enough to stop the heart of an average man.)

XI. Sure signs that wiring is out-of-date

- A. Fuses blow
- B. Circuits trip

- C. Lights dim, blink, flicker
- D. Television picture wobbles
- E. Appliances need longer heating time
- F. Airconditioner fails to do its job
- G. Motor slow to come up to normal speed

XII. Reasons why circuits fail

- A. Circuit overloaded
- B. Fuse or breaker too small
- C. Short circuit
- D. Wire broken
- E. Equipment defective

XIII. Circuit protection devices (Transparency 4)

- A. Fuse
- B. Fusetron
- C. Fustat
- D. Circuit breaker

XIV. Types of common fuses or fusetrans (Transparency 5)

- A. Plug
- B. Cartridge
- C. Blade

SUPPLEMENTAL INFORMATION

Can a 110 Volt Shock Be Fatal??

Many people who wouldn't go within 50 feet of a high-power line, fearlessly fool around with 110 volts at home with the mistaken belief it can't give a deadly shock. It can and it often does.

Nearly 1,000 electrocutions in the United States occur with 110 volts every year. Examples can be found in nearly every county of Kansas over the past five years. These examples range from small children biting or chewing electrical appliance cords to adults using improperly grounded household appliances or tools.

Everyone at some time or another has had a small shock, however, the current usually passes in a hand and out a foot, which is not so bad. When the current passes through the chest, say in one arm and out the other, it can be extremely dangerous. In such an instance, the current can paralyze the respiratory muscles, causing breathing to stop. This paralysis may last even after a person is disconnected from the source of the electricity.

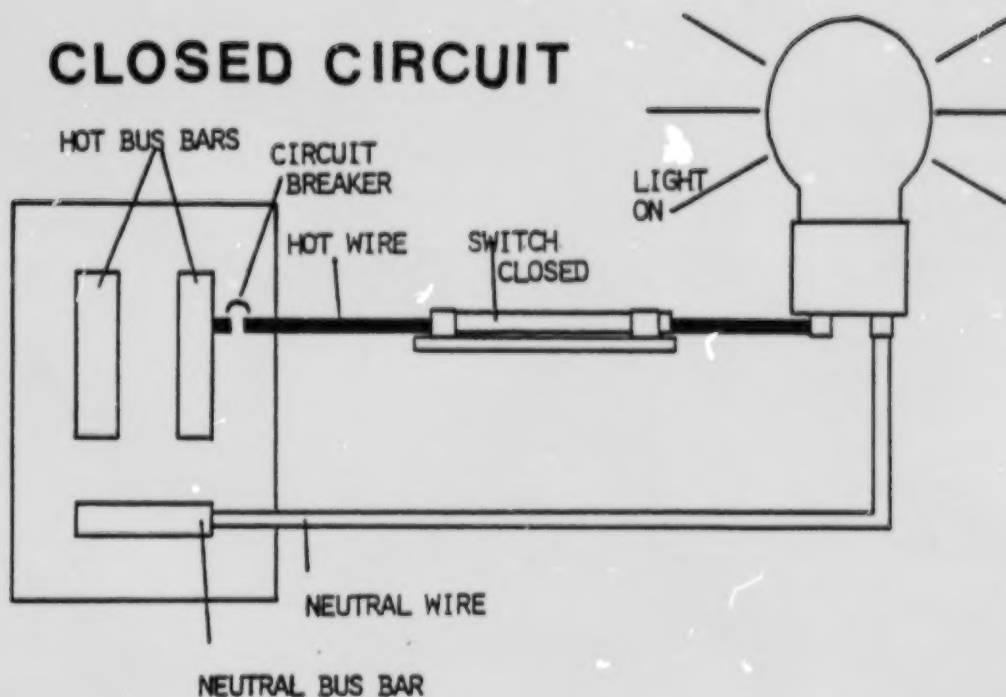
The current may also strike the heart, causing it to go into an uncontrolled fluttering which cuts off the blood and oxygen to the cells. In some cases a high voltage shock is less dangerous than a low voltage one, because the heart fluttering doesn't take place.

Electricity isn't attracted to a person. You have to go out of your way to make yourself attractive to it. Electricity obeys a law of physics. The current is seeking only one thing - the easiest route to the ground - and that's usually not through a person. The body acts as a ground only when you are touching a good ground or standing in a moist area. When you are shocked, you just happen to get in between the source of current and a ground.

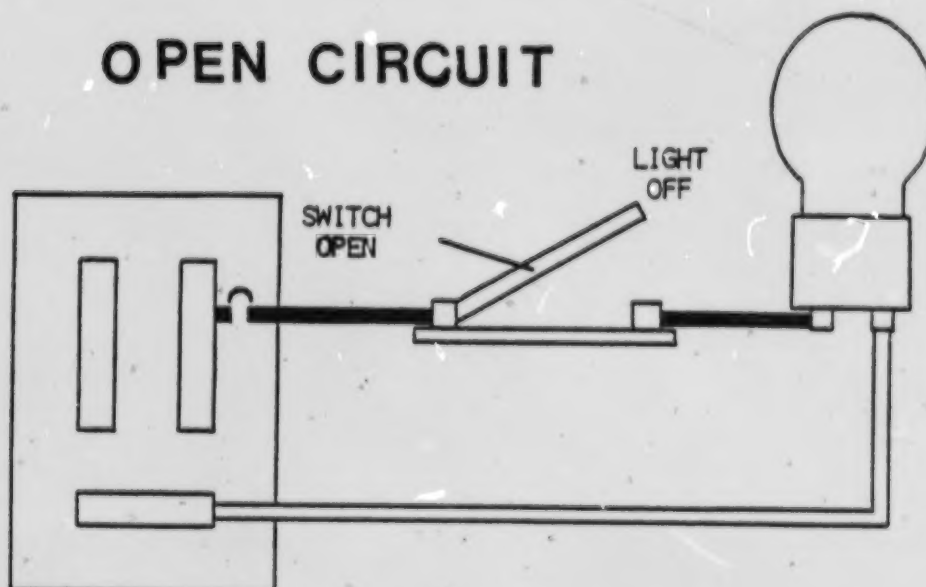
When a slight shock or tickle occurs it indicates a defect in the appliance or tool. Take this as a warning and be glad that it was just a slight shock rather than one of the 1,000 deadly ones that occur each year.

ELECTRICAL CIRCUITS

CLOSED CIRCUIT



OPEN CIRCUIT



Safety Precautions

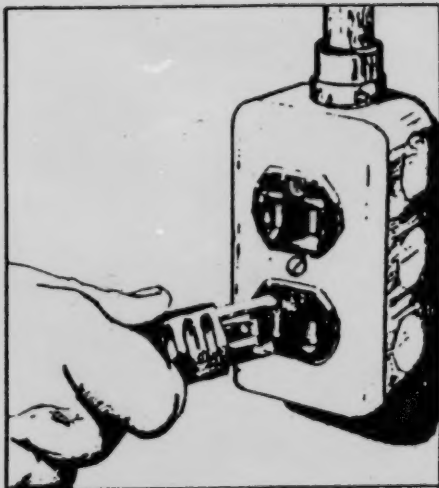


If a hot wire is in contact with a vehicle and the occupant must get out quickly, he should leap without touching the car again.

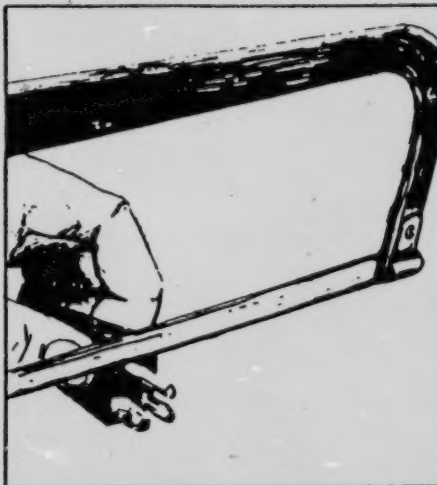


To remove a downed wire from a victim, use a non-conductor such as a long dry wooden or plastic pole or a very dry tree branch.

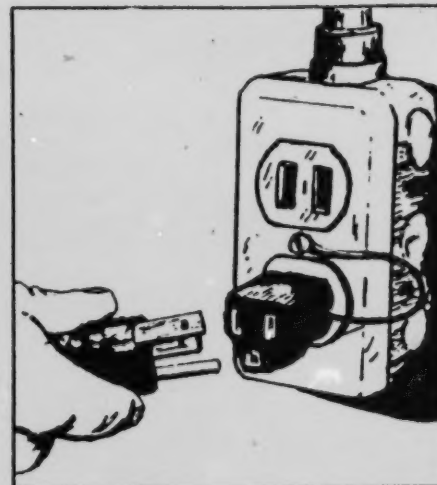
Safety Precautions



Modern homes have
three-wire receptacles.

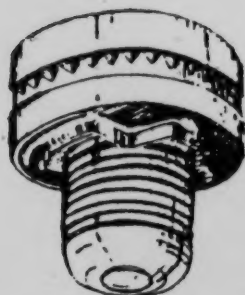


Never cut off
the third prong.



Use adaptor on
old-type receptacle.

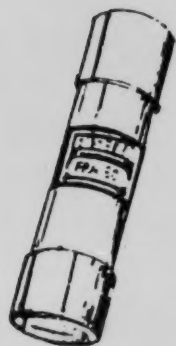
Circuit Protection Devices



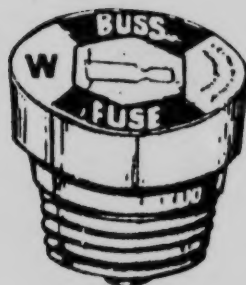
Fustat



Circuit Breaker



Fusetron



Fuse

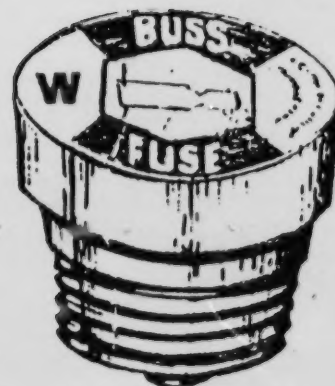
TYPES OF COMMON FUSES OR FUSETRONS



Blade



Cartridge



Plug

ELECTRICAL SAFETY
UNIT II

ASSIGNMENT SHEET #1 - Survey Electrical Conditions

Answer each question below either yes or no if the question applies to your local situation. When completed return to class and turn in to instructor for discussion.

1. Are light cords hung over nails?
2. Are cords showing signs of wear?
3. Do switches work properly?
4. Are lamps touching flammable material?
5. Do lamps touch the wall?
6. Will clothing touch the light globes?
7. Is the lamp cord wrapped around bedstead or fastened to woodwork?
8. Are the floor lamp cords worn?
9. Can the floor lamp cords be stepped on?
10. Is the television set well away from curtains?
11. Is the television set well-ventilated in the back?
12. Is the electric warming pad approved?
13. Are cords found under the rug?
14. Are there enough electrical outlets?
15. Are wires strung through doors?
16. Are any wall receptacles broken?
17. Are all appliances Underwriters' Laboratories approved?
18. Is the refrigerator motor clean?
19. Is the ventilating fan clean?
20. Do fuses "blow" and breakers trip when appliances are connected.
(If so, circuit is overloaded.)
21. Is the pressing iron in good order?
22. Are signal lights working properly on appliances?
23. Is washing machine in good order? Does the cord show signs of wear?
24. Are the motors of dryer and washing machine free of lint and oil?
25. Is the lighting circuit fuse or breaker larger than 15 ampere?
26. Have fuses or circuit breakers been tampered with? (Pennies or other forms of dangerous substitutes used?)
27. Is main switch clean and in good order?

28. Is the panel switch door kept closed?
29. Are extra fuses kept on hand?
30. Are overhead wires to outbuildings properly supported and high enough for proper clearance of vehicles passing under such wires? (10 feet above walkways, 18 feet above driveways.)
31. Are outbuildings properly grounded for lighting protection?
32. Are outlets connected to a grounding terminal?

ELECTRICAL SAFETY
UNIT II

ASSIGNMENT SHEET #2 - Use the National Electrical Code

The following statements are based on the National Electrical Code. Each question should be answered either true or false, depending on the official interpretation of the code.

1. Where the service-entrance conductors are paralleled in two or more raceways, the size of the bonding jumper for each raceway shall be based on the size of service conductors in each raceway. _____
2. The rating of any one portable appliance shall not exceed 50% of the branch circuit rating. _____
3. The smallest size wire permitted to be used for a run overhead from house to garage 45 feet away is #10. _____
4. All circuits supplying gasoline dispensing pumps shall be controlled by a double pole disconnecting means. _____
5. In clothes closets, wall lights may be installed above door. _____
6. All appliances must be provided with a disconnecting means. _____
7. Threadless couplings and fittings are approved in Class 1. _____
8. All major exposed metal parts of a mobile home must be bonded to the grounding terminal of the distribution panel. _____
9. Electric ranges and clothes dryers in a mobile home may be connected with a four-wire cord. _____
10. The NEC permits the use of overcurrent devices which employ the multiple connection of fuses. _____
11. Splices and taps may be located within fixture arms or stems. _____
12. Underground cable run under a building shall be in a raceway that is extended beyond the outside wall of the building. _____
13. A grounding conductor may be run in the same metal raceway with other conductors of the system to which it is connected. _____
14. Circuits of less than 50 volts need not be grounded under any conditions. _____
15. Circuit breakers and plug fuses installed in residential occupancies on circuits of 20 amperes or less shall be of the time-delay type. _____

16. Individual branch circuits may supply any loads. _____
17. The installation of grounding type outlets shall not be used as a requirement that all portable equipment be of the grounded type. _____
18. The minimum size service drop conductor shall not be smaller than No. 8 copper or equivalent except for a limited load. _____
19. Fixture conductors shall not be smaller than No. 18 AWG. _____
20. All splices other than factory splices shall be made in properly installed junction boxes approved for the location. _____

Questions 1-10: Courtesy IAEI News, International Association of Electrical Inspectors

ELECTRICAL SAFETY
UNIT II

ANSWERS TO ASSIGNMENT SHEET #2

1. False-Section 250-94
2. False-Section 210-24 (a)
3. True-Section 730-6 (a)
4. True-Section 514-5
5. True-Section 410-8 (a-1)
6. True-Section 422-20
7. False-Section 501-4
8. True-Section 550-9 (c)
9. True-Section 550-9 (a-2)
10. False-Section 240-14
11. False-Section 410-25
12. True-Section 300-7
13. True-Section 250-98
14. False-Section 250-8
15. True-Section 240-4
16. True-Section 210-24
17. True-Section 210-20
18. True-Section 230-23
19. True-Section 410-8
20. True-Section 422-77

ELECTRICAL SAFETY
UNIT II

TEST

1. Define the following terms.
 - a. Test lamp -
 - b. Grounded ding wire -
 - c. Circuit -
 - d. Fuse -
 - e. National Electrical Code -
2. Name five sources of electrical defects in equipment.
 - a.
 - b.
 - c.
 - d.
 - e.
3. Name three major causes of electrical accidents.
 - a.
 - b.
 - c.
4. Name three ways of freeing a person that is receiving an electrical shock.
 - a.
 - b.
 - c.
5. Name six causes of electrical fires.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.

6. Discuss in a short paragraph the danger and damage caused by improperly using electricity and electrical equipment.

7. Discuss in a short paragraph the type of first aid that should be given to a person who has just received an electrical shock.

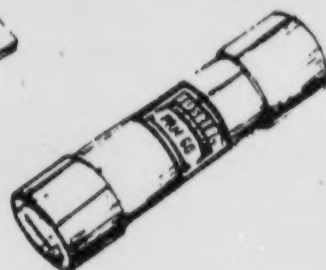
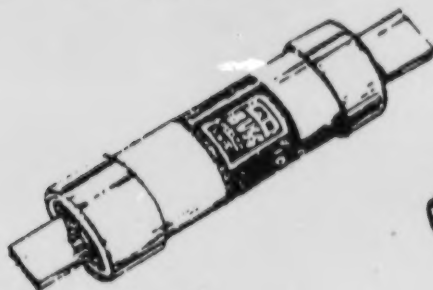
8. Match the types of fires with the correct definition.

_____ a. Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners _____ b. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring. _____ c. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish.	1. Class C 2. Class B 3. Class A
--	---

9. From the list of fire extinguishers below select the ones you would use to control an electrical fire by circling the correct letters.
 - a. Soda acid
 - b. Carbon dioxide
 - c. Foam
 - d. Dry chemical
 - e. Pressurized water

10. Place an "X" in front of the following terms which contribute to death due to receiving an electrical shock.
 - a. Wattage
 - b. Amperes
 - c. Voltage

11. Identify the following types of fuses or fusetrans.



a. _____

b. _____

c. _____

12. Name five sure signs that wiring is out-of-date.

- a.
- b.
- c.
- d.
- e.

13. Name three reasons for circuit failure.

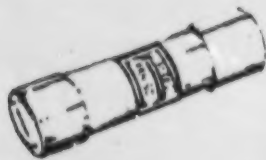
- a.
- b.
- c.

14. Identify the following types of circuit protection devices.

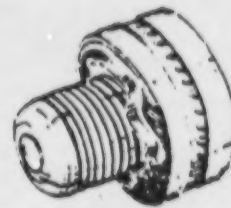


a. _____

b. _____



c. _____



d. _____

ELECTRICAL SAFETY
UNIT II

ANSWERS TO TEST

1.
 - a. A tool used in checking short circuits.
 - b. A green or bare wire which serves as the third wire on 115-volt appliances to provide an easy path for electricity to flow from "hot" to ground in a shorted piece of equipment.
 - c. A completed path through which electricity flows
 - d. A safety device which breaks the flow of electrical current when a circuit becomes overloaded
 - e. A written statement that sets minimum standards for wiring and materials
2. Any five of the following
 - a. Ground wire missing, broken, improperly connected, or not connected at all
 - b. Open conduits; switch boxes damaged or worn
 - c. Worn, wet, or oily insulation causing short circuits
 - d. Defective switches, receptacles, extension cords, and lamp sockets
 - e. Dirty, improperly adjusted electrical equipment
 - f. Loose vibrating machine parts which might cause a short circuit
3.
 - a. Carelessness
 - b. Misuse
 - c. Equipment failure
4.
 - a. Locate line wire or source of electric current and disconnect
 - b. Decide whether to move person or move conductor
 - c. With some type of insulator in your hand, grasp person's arm or leg and quickly pull him free
5.
 - a. Makeshift wiring
 - b. Overload wiring
 - c. Improper fusing
 - d. Neglected maintenance
 - e. Exposed lamp bulbs near flammable materials
 - f. Improper grounding

6. Discussion should contain the following
 - a. 992 persons killed in 1967
 - b. Contributes from 3 to 4 percent of all accidental deaths
 - c. Destroyed \$149,600,000 worth of property in 1968
 - d. Destroyed \$61,200,000 worth of appliances in 1968
7. Discussion should include the following statements
 - a. Call doctor or ambulance immediately
 - b. Only treatment is mouth-to-mouth resuscitation
8.
 - a. 2
 - b. 1
 - c. 3
9.
 - b.
 - d.
10. b
11.
 - a. Blade
 - b. Cartridge
 - c. Plug
12. Any five of the following
 - a. Fuses blow
 - b. Circuit trips
 - c. Lights dim, blink, flicker
 - d. Television picture wobbles
 - e. Appliances need longer heating time
 - f. Airconditioner fails to do its job
 - g. Motor slow to come up to normal speed
13. Any three of the following
 - a. Circuit overloaded
 - b. Fuse or breaker too small
 - c. Short circuit

- d. Wire broken
 - e. Equipment defective
14. a. Breaker
- b. Fuse
 - c. Fuse or Fusetron
 - d. Fustat

SERVICING SMALL ENGINES UNIT X

TERMINAL OBJECTIVE

After completion of Unit X , the student should be able to define terms associated with servicing small engines. He should be able to identify the different types of air cleaners, fuel strainers, and carburetors and demonstrate skills in servicing small gasoline engines. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able to:

1. Define five terms associated with servicing small engines.
2. Name three solutions used in cleaning an engine.
3. Identify given types of air cleaners.
4. Identify given types of fuel strainers.
5. Identify given types of carburetors.
6. Demonstrate the procedures for performing the following jobs:
 - a. Clean and inspect crankcase and accessories.
 - b. Clean and inspect cooling system.
 - c. Service air cleaners.
 - d. Service fuel strainers.
 - e. Clean crankcase breather.
 - f. Change crankcase oil.
 - g. Check spark plug for proper operation.
 - h. Clean and service spark plugs.

SERVICING SMALL ENGINES
UNIT X

SUGGESTED ACTIVITIES

- I. Instructor:
 - A. Provide students with objective sheet.
 - B. Provide students with information and job sheets.
 - C. Make transparencies.
 - D. Discuss terminal and specific objectives.
 - E. Discuss information sheets.
 - F. Demonstrate and discuss procedures outlined in job sheets.
 - G. Give test.
- II. Students:
 - A. Read objectives.
 - B. Study information sheets.
 - C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
 - D. Take test.

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objective sheet
 - B. Information sheets
 - C. Transparency masters
 - 1. TM 1 - Types of Air Cleaners
 - 2. TM 2 - Types of Fuel Filters
 - 3. TM 3 - Types of Carburetors
 - D. Job sheets
 - 1. Job Sheet #1 - Clean and Inspect Crankcase and Accessories
 - 2. Job Sheet #2 - Clean and Inspect Cooling System
 - 3. Job Sheet #3 - Service Oil-Bath Air Cleaner
 - 4. Job Sheet #4 - Service Oiled-Filter Air Cleaner

5. Job Sheet #5 - Service Dry-Filter Air Cleaner
6. Job Sheet #6 - Service Sediment-Bowl Fuel Strainer
7. Job Sheet #7 - Service Screen-Type Fuel Strainer
8. Job Sheet #8 - Service Crankcase Breather
9. Job Sheet #9 - Change Crankcase Oil
10. Job Sheet #10 - Check Spark Plug for Proper Operation
11. Job Sheet #11 - Service Spark Plugs

E. Test

F. Answers to test

II. References:

- A. Small Engines Care, Operation, Maintenance, and Repair, Volume 1. American Association for Agricultural Engineering and Vocational Agriculture.
- B. Briggs and Stratton Repair Instructions III. Milwaukee, Wisconsin: Briggs and Stratton Corporation.
- C. General Theories of Operation. Milwaukee, Wisconsin: Briggs and Stratton Corporation.
- D. Small Gasoline Engines Student Handbook. Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

SERVICING SMALL ENGINES
UNIT X

INFORMATION SHEET

I. Terms and definitions

- A. Butterfly (throttle) valve - A device located in the carburetor which controls the fuel and air
- B. Choke valve - A gate or valve on the air intake side of the carburetor which restricts the air intake, thus causing a richer mixture.
- C. Spark gap - The space between the electrodes of a spark plug through which the spark jumps
- D. Detonation or knock - A hammering force on the piston rather than a uniform pushing force caused by abnormal burning of fuel after spark plug fires
- E. Air cleaner - A device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine

II. Engine cleaning solutions

- A. Commercial solvent called degreaser
- B. Petroleum solvents
 - 1. Kerosene
 - 2. Diesel fuel
- C. Live steam

III. Types of air cleaners (Transparency 1)

- A. Oil-bath
- B. Oiled-Filter
- C. Dry-filter

IV. Types of fuel strainers (Transparency 2)

- A. Combination screen and sediment bowl
- B. Screen in fuel tank
- C. Screen at end of fuel pickup hose

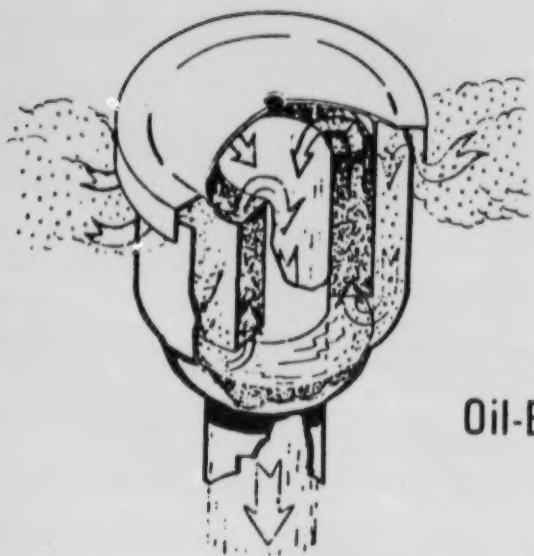
V. Types of Carburetors

A. Suction-Lift

B. Diaphragm

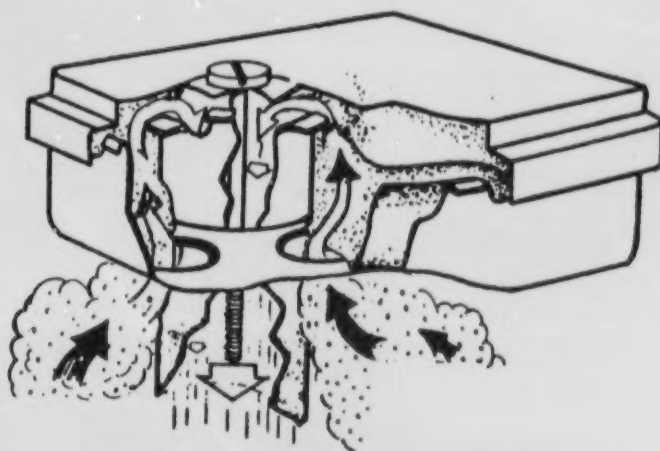
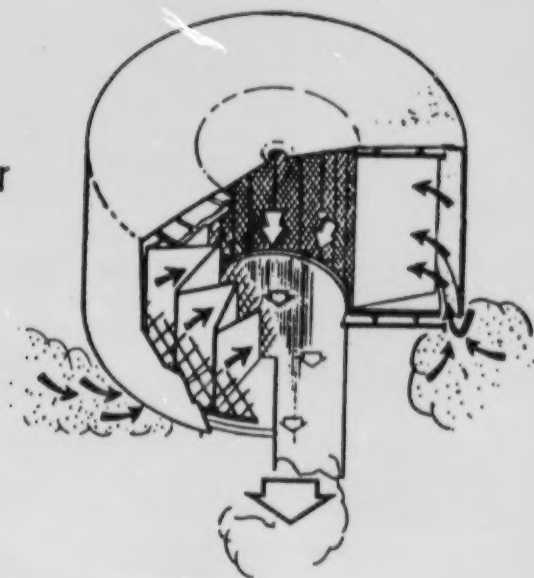
C. Float

Types of Air Cleaners



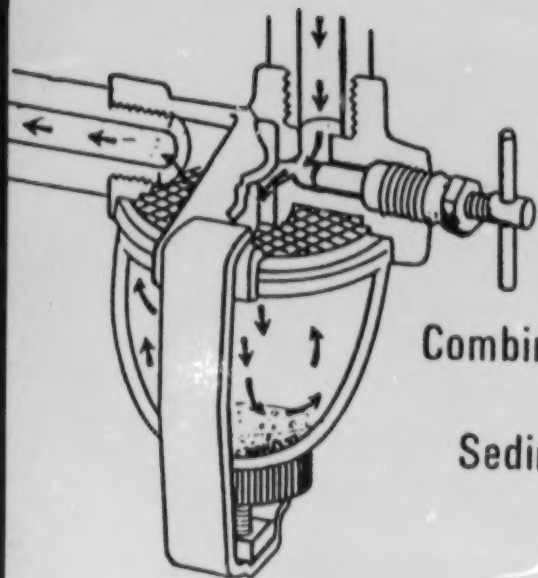
Oil-Bath

Dry-Filter

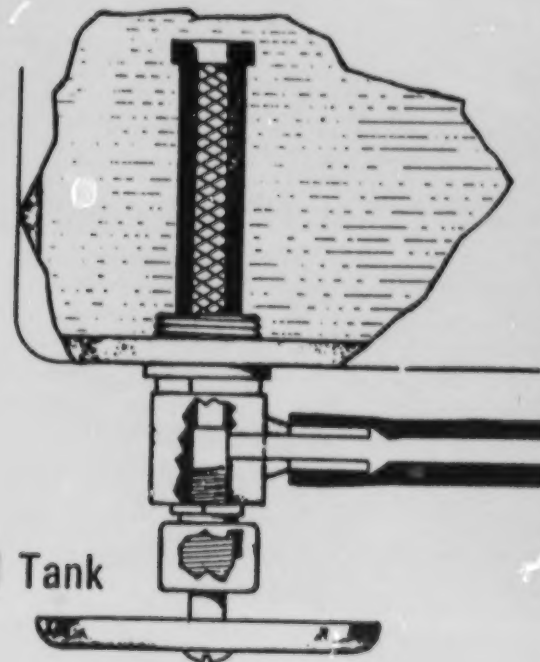


Oiled-Filter

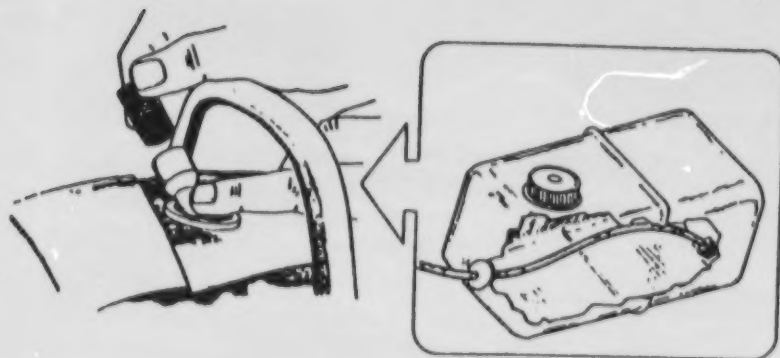
Types of Fuel Filters



Combination Screen
and
Sediment Bowl

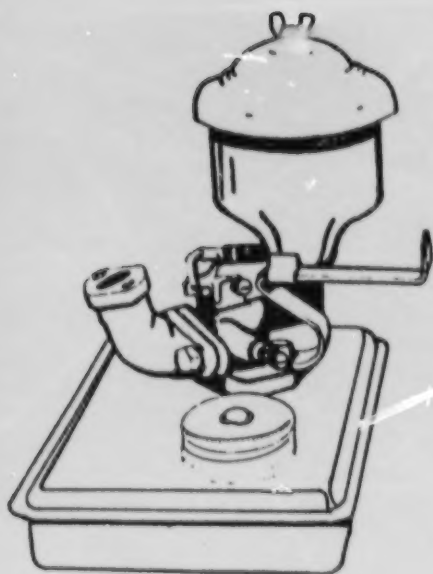


Screen in Fuel Tank

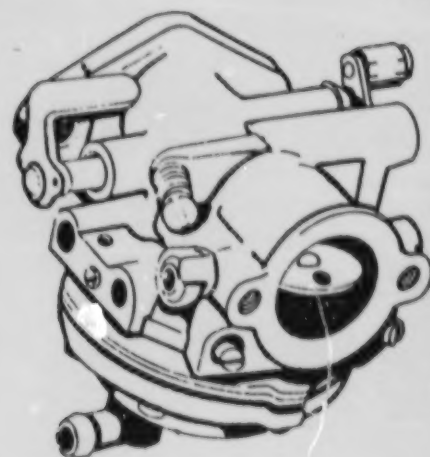


Strainer on Fuel
Pick-up Hose

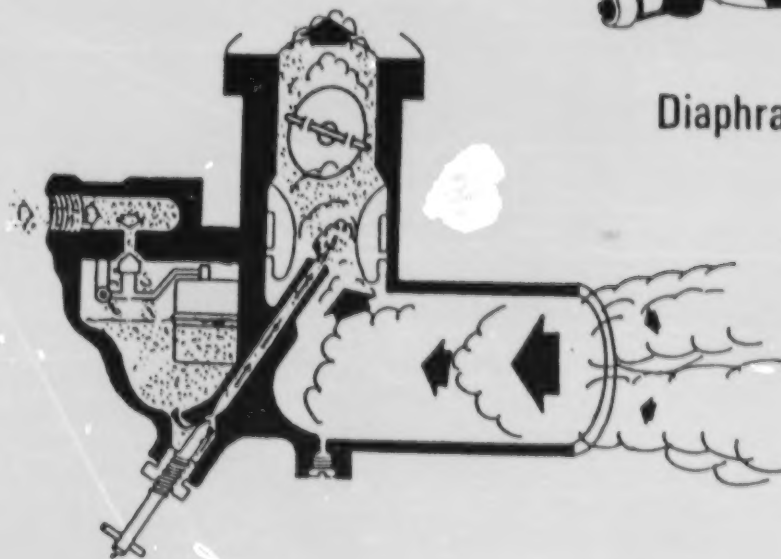
Types of Carburetors



Suction-Lift



Diaphragm



Float

SERVICING SMALL ENGINES UNIT X

JOB SHEET #1 - Clean and Inspect Crankcase and Accessories

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Socket set including:
 - 1. 3/8"
 - 2. 7/16"
 - 3. 1/2"
 - 4. 5/8"
 - 5. 9/16"
 - 6. 3/8" ratchet
- D. Open-end wrenches same as sockets
- E. Wire brush
- F. Empty pan for cleaning
- G. Paint brush
- H. Water hose with nozzle
- I. Scraper or putty knife
- J. Solvent
- K. Hand spray

(NOTE: Do not use gasoline for cleaning an engine. It is highly flammable and an extreme fire hazard. If a degreaser is used, check the instructions on the can.)

II. Procedures

- A. Allow the engine to cool, if it has been running
- B. Remove the blower shroud and cylinder baffles
- C. Inspect for oil and fuel leaks
- D. Remove air-cleaner and cover air-cleaner opening
(NOTE: Cover carburetor intake with a peice of plastic sheeting. Use a rubber band to hold plastic in place.)
- E. Clean the exhaust system
- F. Apply solvent on areas that need cleaning
(NOTE: Apply with a paint brush or hand sprayer until you notice

a thin, well-distributed film.)

- G. Allow solvent to set approximately five minutes
- H. Remove solvent from the engine surface
 - 1. If you used a degreaser, apply a strong stream of water
 - 2. If you used a petroleum solvent, remove with a strong soap solution
- I. Check for areas that have been missed
- J. Remove protective covers
- K. Replace carburetor air-cleaner
- L. Start engine and operate for three to five minutes

SERVICING SMALL ENGINES UNIT X

JOB SHEET #2 - Clean and Inspect Cooling System

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Socket set
- D. Open-end wrench set
- E. Wire brush
- F. Scraper or putty knife

II. Procedures

- A. Close the fuel shut-off valve

(NOTE: Not all engines have shut-off valves. If there is one, it may be either a part of the sediment bowl or a single unit.)

- B. Remove fuel tank if necessary for removing the flywheel shroud.
- C. Remove the recoil starter or screened sheave if equipped with a self-starter
- D. Remove the blower shroud

- E. Remove remaining baffles and deflectors that direct air from shroud and over end area of cylinder.

(NOTE: Do not operate the engine with the shroud and baffles removed.)

- F. Clean inside of shroud and baffles with a small bristle brush or a putty knife
- G. Clean intake screen by washing in solvent
- H. Clean dirt from cylinder fins
- I. Clean dirt from blower flywheel fins
- J. Inspect engine for cracks, blemishes, and broken parts
- K. Reassemble parts in reverse order

SERVICING SMALL ENGINES
UNIT X

JOB SHEET #3 - Service Oil-Bath Air Cleaner

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Container for washing parts
- D. Clean rag
- E. Wooden scraper
- F. Paint brush
- G. Solvent

(NOTE: Do not use gasoline, naptha, or benzine. They are extremely flammable.)

II. Procedures

- A. Disconnect the spark plug wire
- B. Loosen oil cup or cover, and remove the air cleaner
 - 1. Secured by bail wire
 - 2. Secured by wing nut
 - 3. Secured by threaded stud
- C. Cover the exposed air intake
- D. Check depth of sediment deposit in bottom of oil cups
- E. Throw away dirty oil
- F. Clean cup, filter, and other parts with solvents
- G. Check air intake pipe to the carburetor for dirt accumulation
- H. Refill cap with oil to oil level
- I. Remove cover from intake
- J. Assemble the air cleaner; install and tighten
- K. Reconnect the spark plug wire

SERVICING SMALL ENGINES
UNIT X

JOB SHEET #4 - Service Oiled-Filter Air Cleaner

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Container for washing parts
- D. Clean rags
- E. Soap
- F. Paint brush

II. Procedures

- A. Disconnect the spark plug wire
- B. Clean area around air cleaner
- C. Remove filter element cover
- D. Remove filter element
- E. Check condition of the filter element and other parts of the air cleaner
- F. Cover carburetor air intake
- G. Clean filter
- H. Dry filter element
- I. Remove protective cover from the carburetor intake
- J. Clean the carburetor intake
- K. Oil the filter element with a few drops of oil
- L. Install filter element
- M. Install cover
- N. Reconnect spark plug wire

III. Diagram of procedure

Figure A

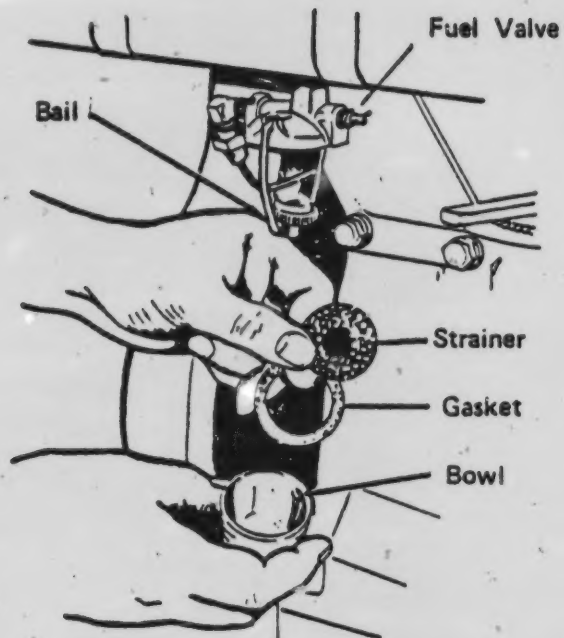


Figure B

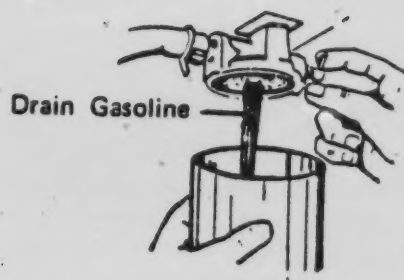
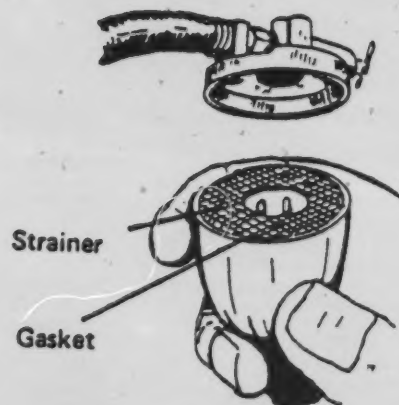


Figure C



SERVICING SMALL ENGINES
UNIT X

JOB SHEET #5 - Service Dry-Filter Air Cleaner

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Clean rags

II. Procedures

- A. Disconnect the spark plug wire
- B. Clean the area around the air cleaner
- C. Remove the filter element cover
- D. Remove the air filter element
- E. Cover the carburetor air intake with cloth or plastic
- F. Check condition of filter element and other parts
- G. Check for holes or tears in element
- H. Clean air filter element

(NOTE: If filter element is paper, clean by tapping it on a flat surface.)

(CAUTION: Do not wash it unless instructed to do so by the manufacturer.)

- I. Remove protective cover from the carburetor intake
- J. Clean filter cover and carburetor intake
- K. Replace filter element
- L. Replace cover
- M. Reconnect spark plug wire

SERVICING SMALL ENGINES
UNIT X

JOB SHEET #5 - Service Dry-Filter Air Cleaner

I. Tools and materials needed

- A. Standard screwdrivers 4" and 6"
- B. Phillips screwdrivers 4" and 6"
- C. Clean rags

II. Procedures

- A. Disconnect the spark plug wire
- B. Clean the area around the air cleaner
- C. Remove the filter element cover
- D. Remove the air filter element
- E. Cover the carburetor air intake with cloth or plastic
- F. Check condition of filter element and other parts
- G. Check for holes or tears in element
- H. Clean air filter element

(NOTE: If filter element is paper, clean by tapping it on a flat surface.)

(CAUTION: Do not wash it unless instructed to do so by the manufacturer.)

- I. Remove protective cover from the carburetor intake
- J. Clean filter cover and carburetor intake
- K. Replace filter element
- L. Replace cover
- M. Reconnect spark plug wire

SERVICING SMALL ENGINES UNIT X

JOB SHEET #6 - Service Sediment-Bowl Fuel Strainer

I. Tools and materials needed

- A. Open-end wrenches 7/16" and 1/2"
- B. Combination pliers
- C. Solvents
- D. Pan for cleaning parts
- E. Cleaning rags
- F. New gasket for glass bowl

II. Procedures

- A. Disconnect spark plug wire
- B. Close fuel shut-off valve
- C. Loosen jam nut and swing the wire bail to one side (Figure A)
- D. Remove bowl with a twisting motion (Figure A)
- E. Remove gasket (Figure A)
- F. Remove strainer (filter) screen (Figure A)
- G. Wash the screen or filter element
- H. Clean and then dry sediment bowl
- I. Open fuel valve and drain out approximately a cup of fuel (Figure B)
(NOTE: Collect fuel in can to avoid a fire hazard.)
- J. Install gasket, strainer, and sediment bowl (Figure C)
- K. Fill the sediment bowl before tightening the jam nut
- L. Tighten bowl against gasket with jam nut
- M. Check for leaks before operating engine
- N. Reconnect spark plug wire to spark plug
- O. Operate engine for a few minutes and recheck for leaks

SERVICING SMALL ENGINES
UNIT X

JOB SHEET #7 - Service Screen-Type Fuel Strainer

I. Tools and materials needed

- A. Open-end wrenches 7/16" and 1/2"
- B. Combination pliers
- C. Solvent
- D. Pan for cleaning parts
- E. Cleaning rags

II. Procedures

- A. Disconnect the spark plug wire
- B. Close fuel shut-off valve (if one is installed)
- C. Remove fuel line from tank
- D. Remove fuel shut-off valve and/or fuel strainer from fuel tank if possible
- E. Clean fuel strainer
- F. Replace fuel strainer assembly in reverse order of removal
- G. Reconnect spark plug wire to spark plug

SERVICING SMALL ENGINES UNIT X

JOB SHEET #8 - Service Crankcase Breather

I. Tools and materials needed

- A. Open-end wrenches 7/16" and 1/2"
- B. Standard screwdriver 8"
- C. Combination pliers
- D. Clean rags
- E. Solvent
- F. Container for cleaning parts
- G. New gasket

II. Procedures

- A. Disconnect spark plug wire
- B. Check breather for proper operation
- C. Remove crankcase breather cover, if installed (Figure A)
- D. Remove the crankcase breather, if it is not a part of the cover
- E. Check breather valve for clearance (Figure B)
 - 1. Check reed valves with a feeler gauge
 - 2. Clearance should be .015" to .030"
- F. Disassemble crankcase breather (Figure C)
- G. Clean parts in petroleum solvent
- H. Reassemble and install breather

III. Diagram of procedure

Figure A

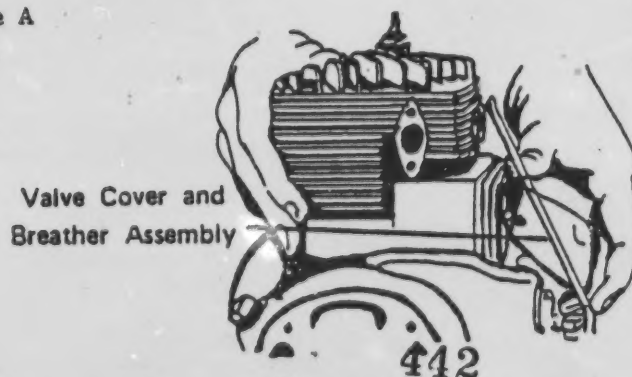


Figure B

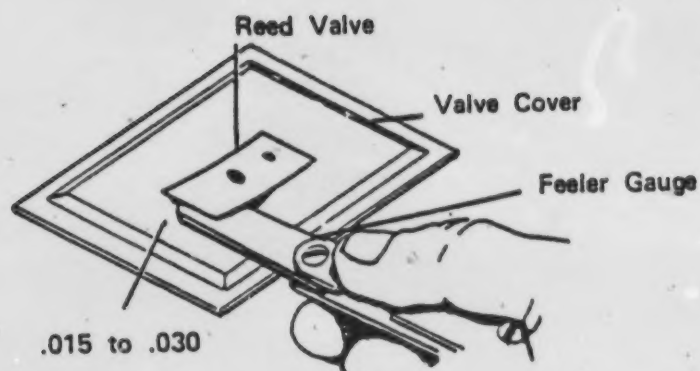
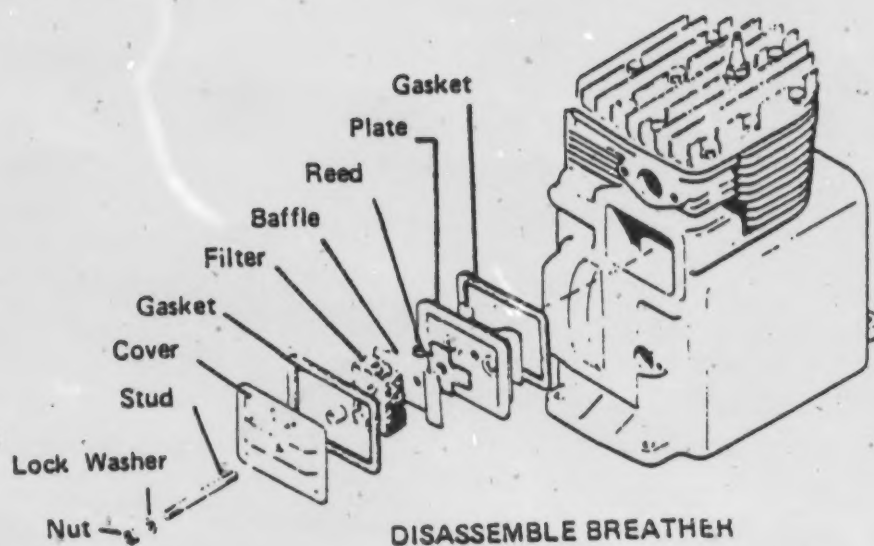


Figure C



SERVICING SMALL ENGINES
UNIT X

JOB SHEET #9 - Change Crankcase Oil

I. Tools and materials needed

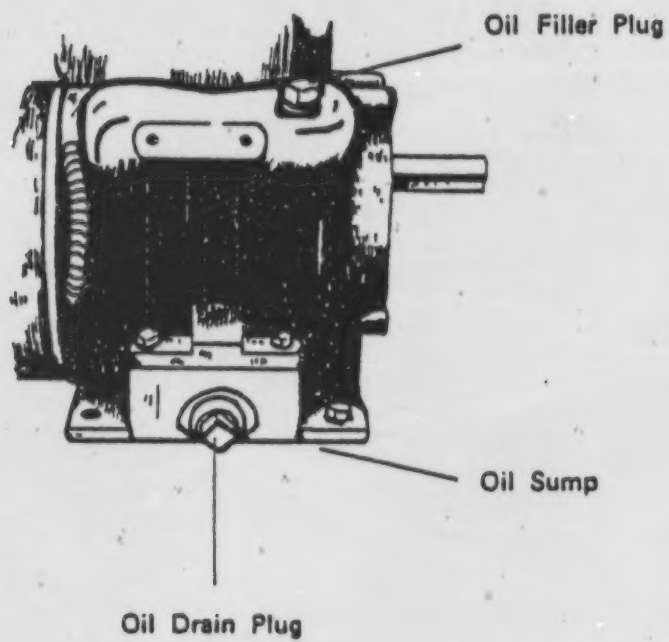
- A. Standard screwdriver 8"
- B. Combination pliers
- C. End wrenches 7/16", 1/2", 9/16", and 5/8"
- D. Funnel
- E. Oil as recommended
- F. Container for old oil
- G. Clean rags

II. Procedures

- A. Operate engine until it is thoroughly heated
- B. Stop engine and disconnect the spark plug wire
- C. Locate drain plug (Figure A)
 - 1. Bottom of oil sump
 - 2. Under soil sump
 - 3. Some drained through filler neck
- D. Clean dirt from around plug before removing plug
- E. Remove drain plug
- F. Allow crankcase to drain for approximately five minutes
- G. Replace drain plug
- H. Refill crankcase with new oil
(NOTE: Use type of oil recommended in the operator's manual.)
- I. Connect spark plug wire and start engine
- J. Check for oil leaks
- K. Stop engine
- L. Recheck oil level

III. Diagram of procedure

Figure A



SERVICING SMALL ENGINES UNIT X

JOB SHEET #10 - Check Spark Plug for Proper Operation

I. Tools and materials needed

- A. Spark plug deep sockets 13/16" x 3/8" and 3/4" x 3/8" drive
- B. Torque wrench handle 3/8" drive
- C. Feeler gauge
- D. Ignition file
- E. Pen knife
- F. Wire brush
- G. Small paint brush
- H. Pan of petroleum solvent

II. Procedures

- A. Disconnect the spark plug wire from the spark plug (Figure A)
- B. Loosen plug one or two turns, and then remove dirt
- C. Remove the spark plug (Figure B)
- D. Reconnect the spark plug wire
- E. Ground spark plug to the engine (Figure C)
- F. Crank the engine one or two turns
- G. Observe the spark at the electrode
(NOTE: If there is no spark, or if spark is weak, proceed to next step.)
- H. Disconnect the spark plug wire from the spark plug
- I. Hold the end of the spark plug wire approximately 1/4 inch from the cylinder head, or use a spark tester (Figure D)
- J. Crank the engine one or two turns
- K. Observe the spark between spark plug wire and the cylinder head
(NOTE: If the spark is blue-orange color, the ignition system is okay; the trouble is in the spark plug.)

III. Diagram of procedure

Figure A

Metal Connector



Figure B

Remove Spark Plug

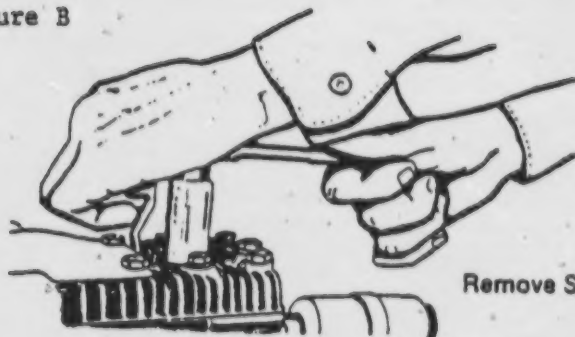


Figure C

Ground Spark Plug

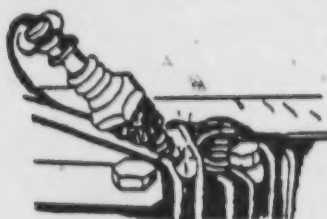
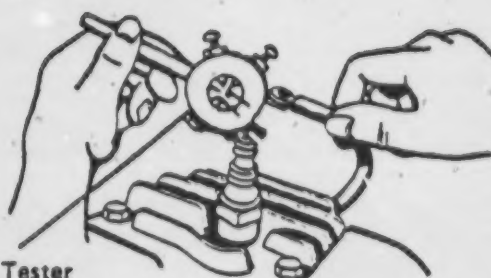


Figure D

Adjustable Gap Spark Tester



SERVICING SMALL ENGINES UNIT X

JOB SHEET #11 - Service Spark Plugs

I. Tools and materials needed

- A. Spark plug deep sockets 13/16" x 3/8" and 3/4" x 3/8" drive
- B. Torque wrench handle 3/8" drive
- C. Feeler gauge
- D. Ignition file
- E. Pen knife
- F. Wire brush
- G. Small paint brush
- H. Pan of petroleum solvent

II. Procedures

- A. Check the condition of the plugs
- B. Remove oily deposits from plugs
- C. Clean threads with wire brush
(NOTE: Do not brush the insulator. It will leave a metallic film which may provide an electrical short to ground.)
- D. Remove deposits from plugs (Figure A)
- E. Blow loose materials from plug with compressed air
- F. Bend the ground electrode enough to allow room for a thin point file (Figure B)
(NOTE: Bend just enough to allow room for file; too much bending will break the ground electrode.)
- G. File electrodes on plugs until both have flat surfaces (Figure B)
- H. Bend the ground electrode back into its original position
- I. Determine proper spark gap spacing for your engine (Figure C)
 - 1. Most plugs set on .025 inch
 - 2. Range from .020" to .040"

III. Diagram of procedure

Figure A

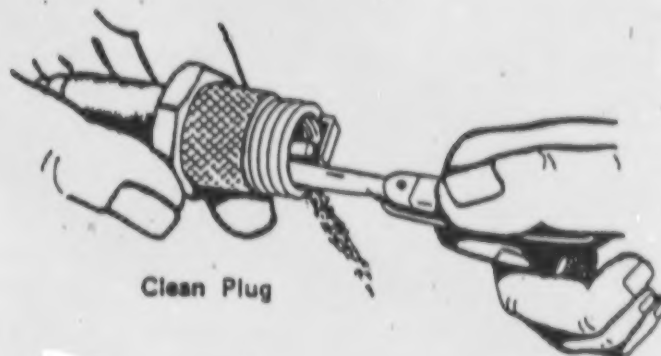


Figure B

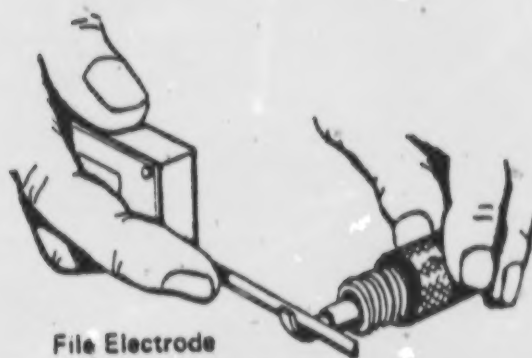
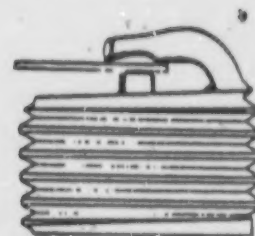
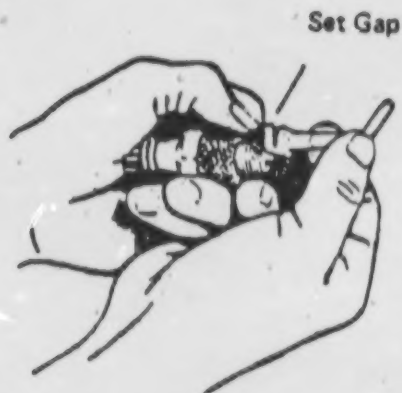
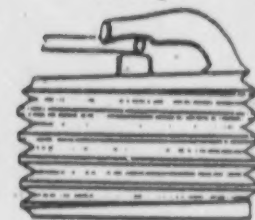


Figure C



Wrong



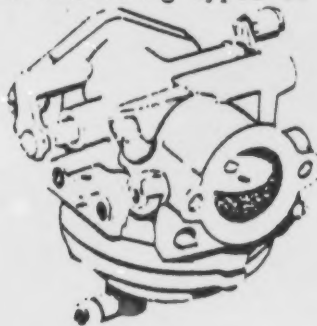
Right

CHECKING THE GAP

SERVICING SMALL ENGINES
UNIT X

TEST

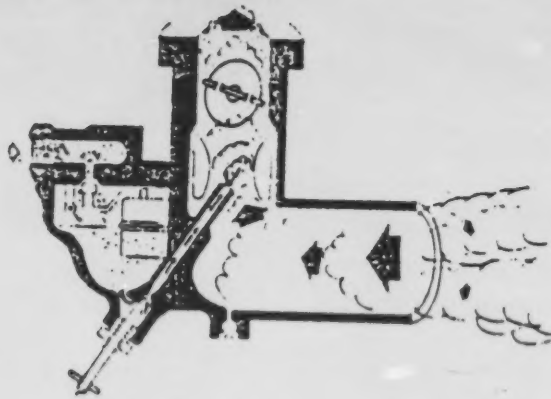
1. Define the following terms.
 - a. Butterfly throttle valve -
 - b. Air cleaner -
 - c. Choke valve -
 - d. Detonation or knock -
 - e. Spark gap -
2. Name three solutions used in cleaning an engine.
 - a.
 - b.
 - c.
3. Identify the following types of carburetors.



a. _____



b. _____

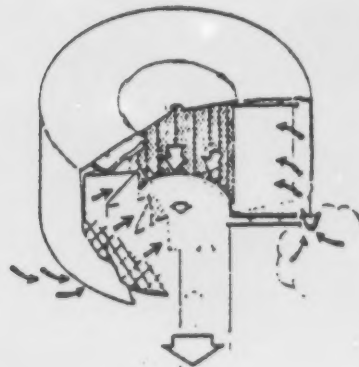


c. _____

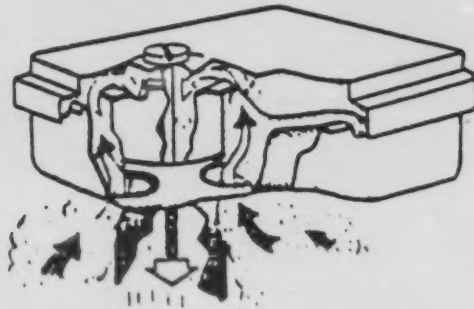
4. Identify the following types of air cleaners.



a. _____

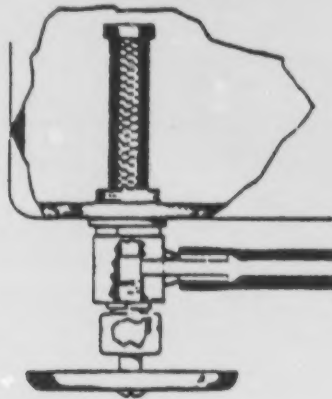


b. _____

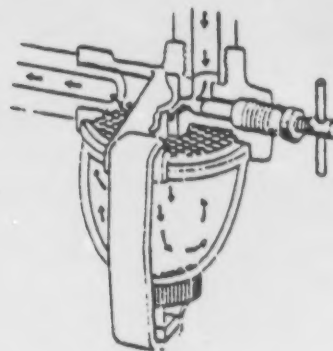


c. _____

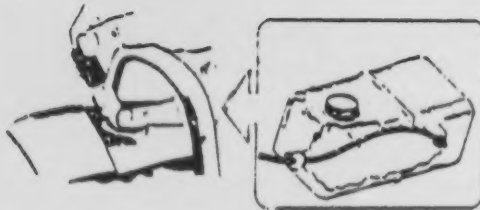
5. Identify the following types of fuel strainers.



a. _____



b. _____



c. _____

6. Demonstrate the procedures for performing the following jobs.
 - a. Clean and inspect crankcase and accessories.
 - b. Clean and inspect cooling system.
 - c. Service air cleaners.
 - d. Service fuel strainers.
 - e. Clean crankcase breather.
 - f. Change crankcase oil.
 - g. Check spark plug for proper operation.
 - h. Clean and service spark plugs.

SERVICING SMALL ENGINES
UNIT X

ANSWERS TO TEST

1.
 - a. Butterfly throttle valve - A device located in the carburetor which controls the fuel and air.
 - b. Air cleaner - A device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine.
 - c. Choke valve - A gate or valve on the air intake side of the carburetor which controls the fuel and air.
 - d. Detonation or knock - A hammering force on the piston rather than a uniform pushing force caused by abnormal burning of fuel after spark plug fires
 - e. Spark gap - The space between the electrodes of a spark plug through which the spark jumps
2.
 - a. Commercial solvent
 - b. Petroleum solvents
 - c. Live steam
3.
 - a. Diaphragm
 - b. Suction-lift
 - c. Float
4.
 - a. Oil-bath
 - b. Dry-filter
 - c. Foam-filter
5.
 - a. Screen in fuel tank
 - b. Combination screen and sediment bowl
 - c. Screen at end of fuel pickup hose
6. Performance skills will be evaluated by the instructor.

FUNDAMENTALS OF ELECTRICITY
UNIT I

TERMINAL OBJECTIVE

After completion of Unit I, the student should be able to define common electrical terms that are necessary in understanding the behavior of electricity and the rules that it follows. He should be able to calculate the cost of electricity and distinguish between a 115-volt and a 230-volt circuit. He should be able to identify various means by which electricity is transported from generator to the farm. This knowledge will be evidenced by scoring eighty-five percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able to:

1. Define ten terms associated with electricity.
2. Name six benefits derived from the use of electricity.
3. Discuss the electron theory.
4. Name the two sources of farm electricity.
5. Name the four means of transporting electricity.
6. Distinguish between a 115-volt service and a 230-volt service.
7. Name the two types of power suppliers.
8. Name the power supplier that services this area.
9. Define Ohm's law as related to electricity.
10. Name the three types of electrical rates.
11. List the two types of kilowatt-hour electric meters.
12. Read an electrical meter and calculate the kilowatt-hours using the residential rate.
13. Calculate the kilowatt-hours for operating an electrical motor for a given number of hours.
14. Calculate problems determining volts, watts, and amps.

FUNDAMENTALS OF ELECTRICITY
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and assignment sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives with students.
- E. Discuss information and assignment sheets with students.
- F. Show film "Electricity for Beginners." (Order from Curriculum and Instructional Materials Center, Stillwater.)
- G. Give test.

II. Students:

- A. Read objective sheet.
- B. Study information sheets.
- C. Work assignment sheets and turn in to instructor.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
- C. Transparency masters
 - 1. TM 1 - Electrical Transporting Lines
 - 2. TM 2-3 - Ohm's Law
 - 3. TM 4 - Pointer-Dial Electric Meter
 - 4. TM 5 - Cyclometer Electric Meter
- D. Assignment sheets
 - 1. Assignment Sheet #1 - Calculate Cost of Operating Electrical Equipment
 - 2. Assignment Sheet #2 - Calculate Volts, Watts, and Amps
 - 3. Assignment Sheet #3 - Calculate Residential Electric Rates
- E. Answers to Assignment sheets

F. Test

G. Answers to Test

II. References:

- A. Brown, Robert H. Farm Electrification, New York: McGraw-Hill Book Company, Inc.
- B. Phipps, Lloyd J., H.F. McColly, L.L. Scranton, and G.C. Cook. Farm Mechanics Text and Handbook, Danville, Illinois: The Interstate Printers and Publishers, Inc.
- C. Farm Electricity. State of Tennessee, Department of Education, Division of Vocational Education.
- D. Basic Electricity and Practical Wiring Lessons, The Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.

FUNDAMENTALS OF ELECTRICITY

UNIT I

INFORMATION SHEET

I. Terms and definitions

- A. Electricity - A source of energy that can be easily converted into light, heat, or power.
- B. Ampere (Amp) - A unit of measure of the rate of flow of electricity through a conductor
- C. Volt - A unit of measure of electrical pressure
- D. Watt - A unit of measure used in determining the rate of energy supplied
- E. Watt-hour - One watt for one hour
- F. Kilowatt (KW) - 1,000 watts
- G. Kilowatt-hour - The reference indicating the use of 1,000 watts of electricity for one hour
- H. Horsepower (hp) - A unit of mechanical power which is equal to 746 watts of electrical power and equal to 33,000 foot pound per minute.
- I. Direct current (DC) - The term meaning that the current flows in one direction at a continuous rate.
- J. Alternating current (AC) - The term meaning that the current reverses at regular intervals
- K. Circuit - A complete path through which electricity flows, such as from the power source to a lamp, through the lamp, and back to the power source.
- L. Switch - A device used to open or close a circuit.
- M. Fuse - safety device which burns out when the current becomes too great.
(NOTE: A fuse must be replaced when blown.)
- N. Circuit breaker - A safety device which opens the circuit by tripping a switch rather than burning out.
(NOTE: A circuit breaker can be reset after time allowed for cooling)
- O. Conductors - The wires which carry the electricity, or through which electricity flows
- P. Insulation - A protective covering over wires to prevent completing a circuit except where desired
- Q. Hot wires - The current carrying conductors with electrical pressure on them (usually black or red) connected to fuse or circuit breaker at distribution panel
- R. Neutral wires - The current carrying conductors with no pressure on them (usually white) connected to neutral base at the distribution panel

- S. Grounding - The connection of the neutral part of the metallic electrical system to the earth to reduce the possibility of damage from lightning, and the connection of the housings of electrical equipment to the earth to minimize the danger of electrical shock.
- T. Short circuit - An improper connection between hot and neutral wires or between hot wires
- U. Voltage drop - A loss in electrical pressure from its source to its point of use
- V. U.L. (Underwriter's Laboratories) - A nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet minimum standards for safety and quality
- W. Service transformer - An alternating current device used to change voltage from primary to secondary, such as: from 6,900 volts primary to 115 volts or 230 volts secondary; or from 115 volts primary to 230 volts secondary
- X. Single phase - A type of electric service available to most farms requiring one transformer between power supplier and customer
- Y. Three phase - A type of electric service providing three independent AC currents which reach peak voltage at different times.
- Z. Meter - An instrument which records the amount of electrical energy used (kilowatt hours)
- AA. Resistance - The property of a substance that opposes the flow of current (measured in Ohms)
- BB. Foot pounds - A unit of energy, or work, needed to raise one pound against the force of gravity the height of one foot.

II. Benefits of using electricity

- A. Light
- B. Power
- C. Heat
- D. Cooling
- E. Communications
- F. Special controls

III. Electron theory

- A. Electrons - Ones having a negative charge
- B. Protons - Ones having a positive charge
- C. Negative electrons - Ones which move freely

(NOTE: Negative electrons circulate about positive protons which form the nucleus of the atoms.)

IV. Sources of farm electricity

- A. Individual plant
- B. Central station and distribution lines (power generally purchased)

V. Means of transporting electricity (Transparency 1)

- A. Transmission lines - The lines that extend from generating station to substation or from substation to substation
- B. Distribution lines - The lines beginning at a substation and extending out over the countryside, usually ranging from three to fifteen miles
- C. Service drop lines - The lines that run from a distribution line to the meter pole
- D. Feeder lines - The lines that run from the meter pole to the house

VI. Differences between 115-volt service and 230-volt service

- A. 115-volt service - Two lines running to the house
- B. 230-volt service - Three lines running to the house

VII. Types of power suppliers

- A. REA Cooperatives
- B. Public or private companies

VIII. Local power supplier

- A.
- B.

IX. Ohm's law - All electric circuits have a definite relationship between the pressure, the electron motion, and the opposition (Transparencies 2 and 3)

- A. Voltage - Current x resistance
- B. Voltage - E volts
- C. Current - I amps
- D. Resistance - R ohms

X. Electrical rates

- A. Residential
- B. Commercial
- C. Special

D. Example of calculating residential rates:

1. First 20 kwh's at 7¢ per kwh
2. Next 20 kwh's at 5¢ per kwh
3. Next 60 kwh's at 3¢ per kwh
4. Next 120 kwh's at 2 1/2¢ per kwh
5. Over 220 kwh's at 1¢ per kwh

E. Customer used 300 kwh's

- | | |
|-----------------------------|----------|
| 1. First 20 kwh's at 7¢ | - \$1.40 |
| 2. Next 20 kwh's at 5¢ | - 1.00 |
| 3. Next 60 kwh's at 3¢ | - 1.80 |
| 4. Next 120 kwh's at 2 1/2¢ | - 3.00 |
| 5. Next 80 kwh's at 1¢ | - .80 |
| 6. Total cost of 300 kwh's | - \$8.00 |

XI. Types of kilowatt-hour meters (transparency 4 and 5)

- A. Pointer-dial
- B. Cyclometer

(NOTE: Rr refers to the number of kilowatt hours that pass through meter for each revolution of meter disc)

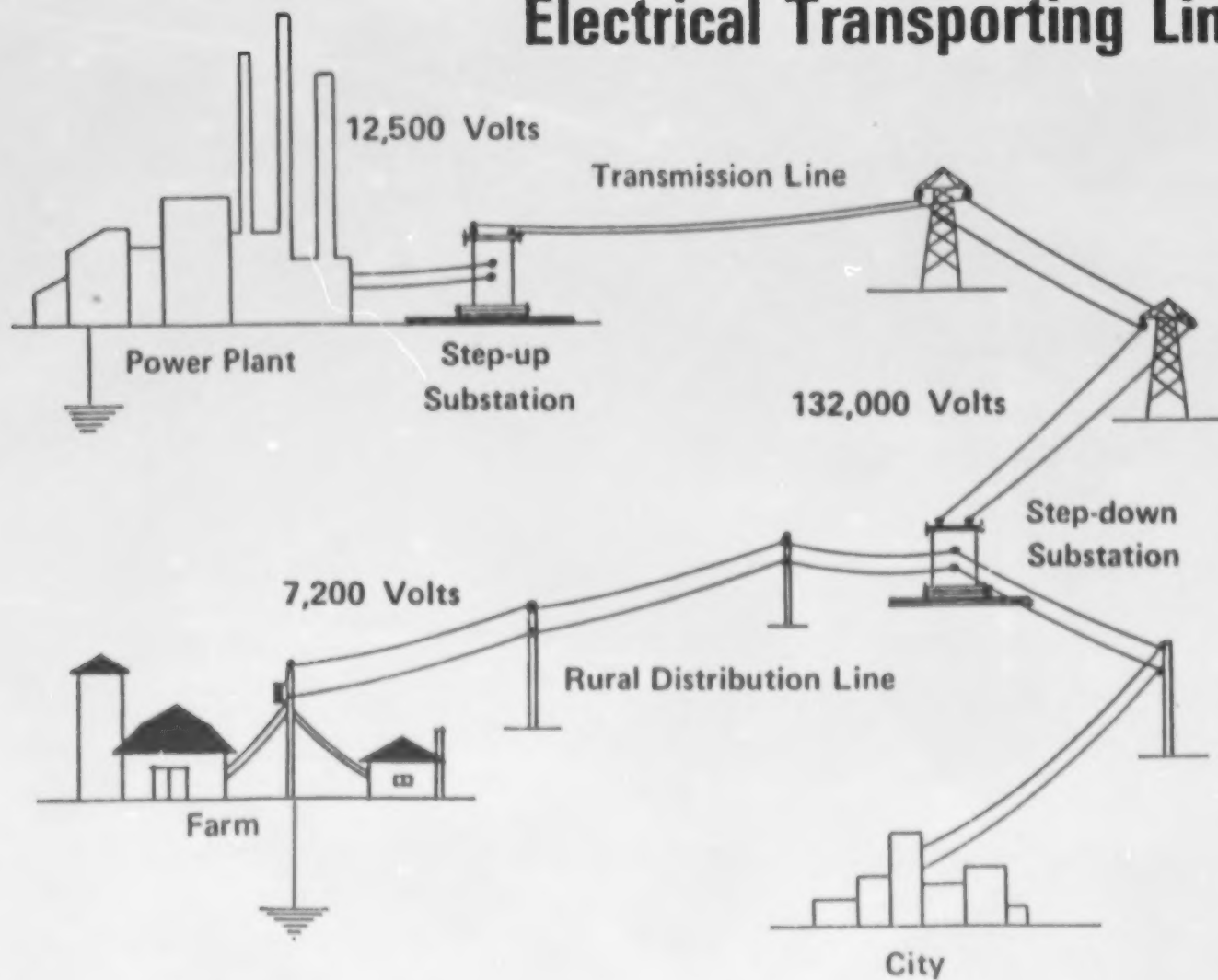
XII. Cost of operating electrical equipment

- A. Watts x hours of operation = Watt-hours
- B. Kilowatt-hours (kwh) = $\frac{\text{Watts} \times \text{Hours}}{1000}$

C. Motors

1. Multiply 1,200 by hp rating if motor is smaller than one-half hp
2. Multiply 1,000 by hp rating if motor is one-half hp or greater
3. Example:
 - a. 1/4 hp motor x 1,200 = 300 watts
 - b. 300 watts x 2 hours of operation = 600 watt-hours
 - c. $\frac{600}{1000} = .6 \text{ kwh's}$

Electrical Transporting Lines



OHM'S Law

$$I = \frac{E}{R}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{OHMS}}$$

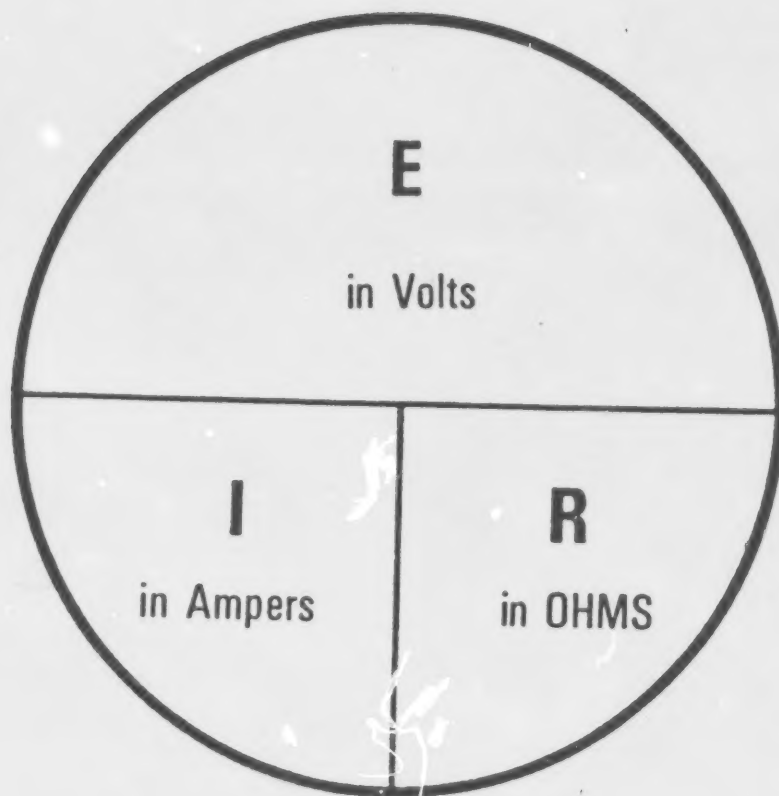
$$E = IR$$

$$\text{Volts} = \text{Amperes} \times \text{OHMS}$$

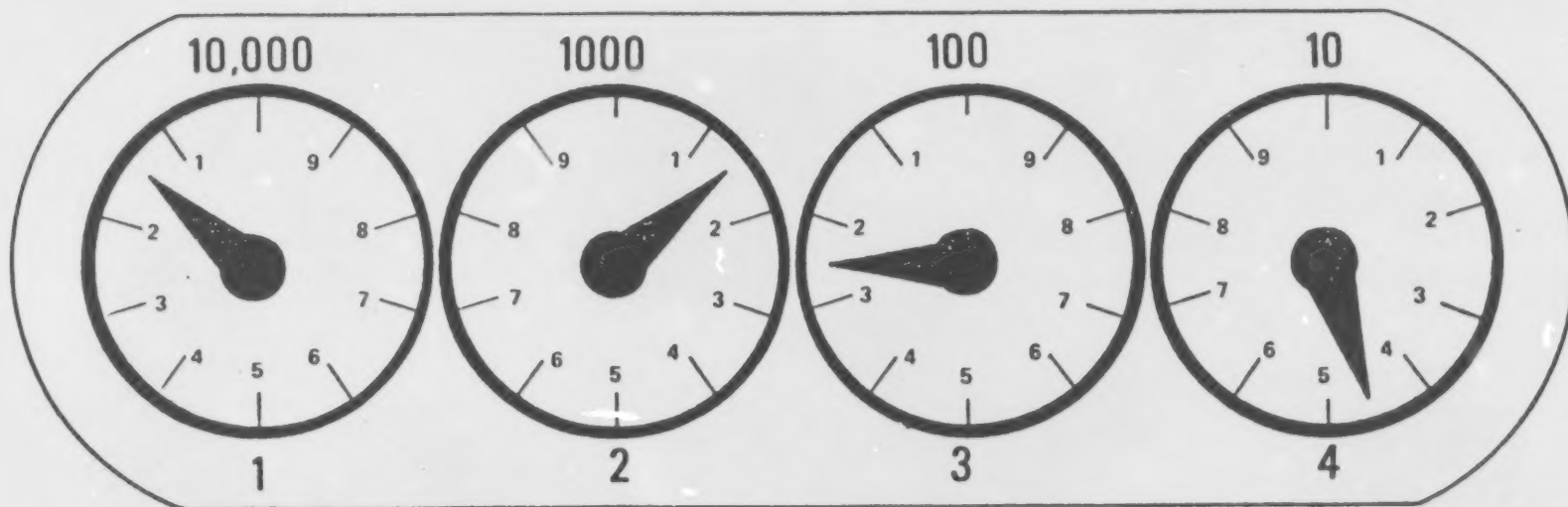
$$R = \frac{E}{I}$$

$$\text{OHMS} = \frac{\text{Volts}}{\text{Amperes}}$$

OHM'S Law

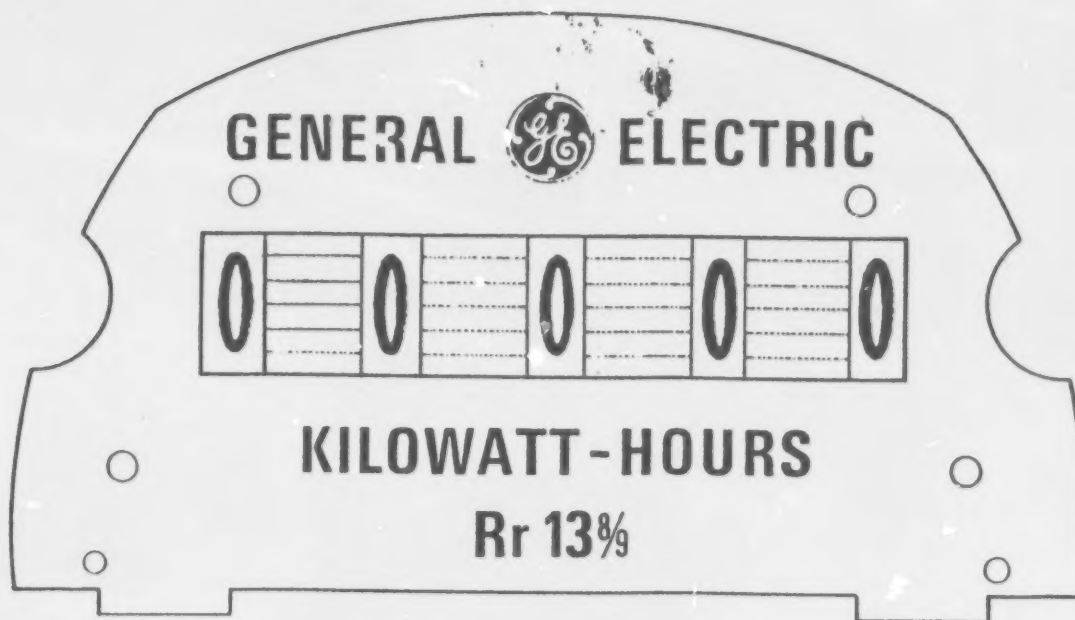


Pointer-Dial Electric Meter



Read the last figure passed by the hand. When the hand seems to be on the number, the dial to the right should be consulted to see whether or not the number has been passed. Dial 4 shows the number of tenths. Dial 3 shows the number of one-hundredths. Dial 2 shows the number of one-thousandths.

Cyclometer Electric Meter



FUNDAMENTALS OF ELECTRICITY
UNIT I

ASSIGNMENT SHEET #1 - CALCULATE COST OF OPERATING
ELECTRICAL EQUIPMENT

Work each of the problems listed below. All problems should be worked using the average cost of 2¢ per kwh for electricity. Be sure to show your work.

1. How much would it cost to operate a 1/4-hp motor for 12 hours?
2. How much would it cost to operate a 2-hp motor for 10 hours?
3. How much would it cost to operate a 100-watt light bulb for a period of 12 hours?
4. An electric refrigerator requires 150 watts of electric power. It operates an average of four hours each day. How many kilowatt-hours would be used in 30 days, and how much would it cost for operation?
5. What would be the cost of operating a heat lamp that pulls 200 watts for 5 hours?

FUNDAMENTALS OF ELECTRICITY
UNIT I

ASSIGNMENT SHEET #2 - CALCUALTE VOLTS, WATTS, AND AMPS

Work each of the problems below. When you have finished working the problems turn in to the instructor.

1. Calculate ohms when:

- a. Amps - 4 and volts - 230
- b. Amps - 15 and volts - 115
- c. Amps - 8 and volts - 120

2. Calculate volts when:

- a. Amps - 12.5 and ohms - 9.6
- b. Amps - 6 and ohms - 19
- c. Amps 3 and ohms - 80

3. Calculate amps when:

- a. Volts - 125 and ohms - 11
- b. Volts - 240 and ohms - 11
- c. Volts - 120 and ohms - 60

FUNDAMENTALS OF ELECTRICITY
UNIT I

ASSIGNMENT SHEET #3 - CALCULATE RESIDENTIAL ELECTRIC RATES

Work each of the problems below showing your work. Read the example of the electric kilowatt-hour meters, subtract the previous reading, and calculate the electric bill. Each problem should be figured using the rate listed below:

First 20 kwh's at 7¢ per kwh
Next 20 kwh's at 5¢ per kwh
Next 60 kwh's at 3¢ per kwh
Next 120 kwh's at 2 1/2¢ per kwh
Over 220 kwh's at 1¢ per kwh

Meter A

Reading _____
Previous reading 4459

Meter B

Reading _____
Previous reading 5680

Meter C

Reading _____
Previous reading 8450

Meter D

Reading _____
Previous reading 1000

FUNDAMENTALS OF ELECTRICITY
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

A. Assignment sheet #1

1. 7.2¢
2. 40¢
3. 2.4¢
4. 36¢
5. 2¢

B. Assignment Sheet #2

1.
 - a. 57.5
 - b. 7.67
 - c. 15.0
2.
 - a. 120.0
 - b. 114.0
 - c. 240.0
3.
 - a. 11.36
 - b. 21.81
 - c. 2.0

C. Assignment Sheet #3

Meter A	Reading	4699	Bill price \$ 7.40
	Previous reading	<u>4459</u>	
		240 kwh	
Meter B	Reading	6798	Bill price \$16.18
	Previous reading	<u>5680</u>	
		1118 kwh	
Meter C	Reading	8766	Bill price \$ 8.16
	Previous reading	<u>8450</u>	
		316 kwh	
Meter D	Reading	1965	Bill price \$14.65
	Previous reading	<u>1000</u>	
		965 kwh	

FUNDAMENTALS OF ELECTRICITY
UNIT I

TEST

1. Define the following terms.
 - a. Volt-
 - b. Switch-
 - c. Conductor-
 - d. Voltage drop-
 - e. Meter-
 - f. Resistance-
 - g. Kilowatt-
 - h. Watt-
 - i. Electricity-
 - j. Amp-
2. Name six benefits derived from the use of electricity.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.
3. Discuss the electron theory.

4. Name the two sources of farm electricity.
 - a.
 - b.
5. Name four means of transporting electricity.
 - a.
 - b.
 - c.
 - d.
6. Indicate by placing an "X" in the blank which of the following statements represents a 230-volt service.
 - ☐ a. Two lines running to the house
 - ☐ b. Three lines running to the house
7. Name two types of power suppliers.
 - a.
 - b.
8. What is the name of the power supplier that serves this school area?
9. What are the three types of electrical rates?
 - a.
 - b.
 - c.
10. Define Ohm's law as related to electricity.
11. What are the two types of kilowatt-hour electric meters?
 - a.
 - b.

12. Calculate ohms:
- a. Amps = 10 and volts = 220 _____
- b. Amps = 8 and volts = 110 _____
13. Calculate volts:
- a. Amps = 10.5 and ohms = 15 _____
- b. Amps = 2 and ohms = 80 _____
14. Calculate amps:
- a. Volts = 115 and ohms = 10 _____
- b. Volts = 230 and ohms = 6 _____
15. Calculate the cost of 150 kilowatt-hours of electricity. Use the residential rates.
- First 20 kwh's at 7¢ per kwh
Next 20 kwh's at 5¢ per kwh
Next 60 kwh's at 3¢ per kwh
Next 120 kwh's at 2 1/2¢ per kwh
Over 220 kwh's at 1¢ per kwh
16. How many kilowatt-hours will a 200 watt pump use that runs for four hours?
17. How much will it cost to operate a 1/4 hp electric motor for eight hours if the average rate of electricity costs 4¢ per kwh?

FUNDAMENTALS OF ELECTRICITY
UNIT I

ANSWERS TO TEST

1.
 - a. A unit of measure of electric pressure
 - b. A device used to open or close a circuit
 - c. The wires which carry the electricity, or through which electricity flows.
 - d. A loss in electrical pressure from its source to its use
 - e. An instrument which records the amount of electrical energy in kilowatt-hours
 - f. The property of a substance that opposes the flow of current
 - g. 1,000 watts
 - h. A unit of measure used in determining the rate of energy supplied
 - i. A source of energy that can be easily converted into light, heat, or power.
 - j. A unit of measure of the rate of flow of electricity through a wire

2.
 - a. Light
 - b. Power
 - c. Heat
 - d. Cooling
 - e. Communications
 - f. Special controls

3. Discussion should contain the following information:
 - a. Electrons have negative charge
 - b. Protons have positive charge
 - c. Negative electrons move freely
 - d. Negative electrons circulate about positive protons which form the nucleus of the atoms

4.
 - a. Individual plant
 - b. Central station and distribution lines

5.
 - a. Trnasmission lines
 - b. Distribution lines
 - c. Service drop lines
 - d. Feeder lines
6. b.
7.
 - a. REA Cooperatives
 - b. Public or private companies
8. _____
9.
 - a. Residential
 - b. Commercial
 - c. Special
10. All electric cirucits have a definite relationship between the pressure, the electron motion, and the opposition.
11.
 - a. Cyclometer
 - b. Pointer-dial
12.
 - a. 22.0 ohms
 - b. 13.7 ohms
13.
 - a. 157.5 volts
 - b. 160.0 volts
14.
 - a. 11.5 amps
 - b. 38.3 amps
15. \$5.45
16. .8 kwh's
17. 9.6¢

ENGINE OPERATION

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to define terms associated with small engines. The student should be able to identify operating positions and valve parts and describe the operation and use of small engines. The student should be able to describe the types of valve failures, faulty compression and the functions of the piston rings, carburetion system and ignition system. The student should be able to disassemble, make appropriate checks, and reassemble a small gasoline engine. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able to:

1. Define five terms associated with small gasoline engine repair.
2. Name five machines that are powered by a small gasoline engine.
3. Identify the three basic operating positions on small gasoline engines.
4. Distinguish between a two-stroke cycle engine and a four-stroke cycle engine.
5. Name and describe the four principal events in the operation of a four-cycle engine.
6. Name three advantages of an air-cooled engine.
7. Identify the parts of a valve when given a drawing illustrating the parts.
8. Identify and describe three types of valve failure when given a drawing showing each type.
9. Name the simple rule for testing compression.
10. Name ten factors that can cause faulty compression.
11. Name three functions of piston rings.
12. Name the types of piston rings when given a drawing showing each type.
13. Describe the primary functions of the carburetion system.
14. Name the three basic types of carburetors.
15. Describe the operating principle of the carburetor.
16. Identify the parts of a float-type carburetor when given a drawing illustrating the parts.

17. Name the two basic types of small engine ignition systems.
18. Describe the function of the ignition system.
19. Identify the parts of the ignition systems when given a drawing illustrating the parts.
20. Complete an engine inspection chart.
21. Demonstrate the ability to:
 - a. Disassemble a small gasoline engine.
 - b. Make appropriate checks.
 - c. Reassemble a small gasoline engine.

ENGINE OPERATION

SUGGESTED ACTIVITIES

- I. Instructor:
 - A. Provide students with objective sheet.
 - B. Provide students with information, job, and assignment sheets.
 - C. Make transparencies.
 - D. Discuss terminal and specific objectives.
 - E. Discuss information and assignment sheets.
 - F. Demonstrate and discuss procedures outlined in the job sheets.
 - G. Give test.
- II. Students:
 - A. Read objectives.
 - B. Study information sheets.
 - C. Complete assignment sheet and turn in to instructor.
 - D. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
 - E. Take test.

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objectives
 - B. Information sheets
 - C. Transparency masters
 - 1. TM 1 - Engine Operating Positions
 - 2. TM 2 - Principal Events in the Operating Cycle of an Engine
 - 3. TM 3 - Valve Parts
 - 4. TM 4 - Types of Valve Failures
 - 5. TM 5 - Testing Compression
 - 6. TM 6 - Causes of Poor Compression
 - 7. TM 7 - Types of Piston Rings
 - 8. TM 8 - Fuel Supply Systems

9. TM 9 - Carburetor Operating Principle
10. TM 10 - Carburetor Choke Valve
11. TM 11 - Carburetor Adjusting Valve
12. TM 12 - Float-Type Carburetor
13. TM 13 - Parts of a Float Carburetor
14. TM 14 - Parts of Magneto Ignition System

D. Assignment sheet

1. Assignment Sheet #1 - Engine Inspection Chart

E. Job sheets

1. Job Sheet #1 - Disassemble a Small Gasoline Engine
2. Job Sheet #2 - Checking Coils and Condensers
3. Job Sheet #3 - Checking Cylinder Bore
4. Job Sheet #4 - Checking Valve Guides and Crankcase Bearings
5. Job Sheet #5 - Checking Piston Rings, Piston Pins and Rod
6. Job Sheet #6 - Refacing Valves and Valve Seats
7. Job Sheet #7 - Reassemble a Small Gasoline Engine

F. Test

G. Answers to test

II. References:

- A. Small Engines Care, Operation, Maintenance, and Repair, Volume 1, American Association for Agricultural Engineering and Vocational Agriculture.
- B. Briggs and Stratton Repair Instructions III, Briggs and Stratton Corporation, Milwaukee, Wisconsin.
- C. General Theories of Operation, Briggs and Stratton Corporation, Milwaukee, Wisconsin.
- D. Small Gasoline Engines Student Handbook, Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.
- E. Small Engines - Principles of Operation, Trouble Shooting, and Tune-Up, University of Illinois, College of Agriculture, Vocational Agriculture Service, Urbana, Illinois.
- F. Shinn, Glen C. and Curtis R. Weston, Working in Agricultural Mechanics, McGraw Hill Inc., c. 1978

ENGINE OPERATION

INFORMATION SHEET

I. Terms and definitions

- A. Camshaft - The shaft containing lobes or cams to operate the engine valves.
- B. Carburetor - A device for automatically mixing fuel in the proper proportion with air to produce a combustible gas
- C. Combustion - The process of burning
- D. Combustion chamber - The volume of the cylinder above the piston with the piston on top center.
- E. Compression - The reduction in volume or the squeezing of a gas
- F. Condenser - A device for temporarily collecting and storing a surge or electrical current for later discharge
- G. Conductor - A material along or through which electricity will flow with a slight resistance
- H. Connecting rod - A rod that connects the piston to the crankshaft
- I. Crankcase - The housing in which the crankshaft and many other parts of the engine operate.
- J. Crankshaft - The main shaft of the engine which, in conjunction with the connecting rods, changes the reciprocating motion of the pistons into rotary motion.
- K. Cylinder - A round hole having some depth bored to receive a piston also sometimes referred to as bore or barrel.
- L. Cylinder block - The largest single part of an engine; the basis or main mass of metal in which the cylinders are bored or placed.
- M. Cylinder head - A detachable portion of an engine fastened securely to the cylinder block which contains all or portion of the combustion chamber
- N. Exhaust pipe - The pipe connecting the engine to the muffler to conduct the exhausted gases away from the engine
- O. Gasket - Anything used as a packing, such as a non-metallic substance placed between two metal surfaces to act as a seal
- P. Governor - A device consisting of control which is used to regulate engine speed
- Q. Ignition system - The means for igniting the fuel in the cylinder including spark plugs, wiring, ignition, distributor ignition coil; source of electrical supply
- R. Intake valve - A valve which permits a fluid or gas to enter the chamber and seals the exit
- S. Piston - A cylindrical part closed at one end which is connected to the

crankshaft by the connecting rod

- T. Piston head - The part of the piston above the rings
- U. Piston pin - The journal for the bearing in the small end of an engine connecting rod which also passes through piston walls; also known as a wrist pin
- V. Piston ring - An expanding ring placed in the grooves of the piston to provide a seal to prevent the passage of fluid or gas past the piston
- W. Score - A scratch, ridge, or groove marring a finished surface.
- X. Spark - An electrical current possessing sufficient pressure to jump through the air from one conductor to another.
- Y. Spark gap - The space between the electrodes of a spark plug through which the spark jumps
- Z. Spark plug - A device inserted into the combustion chamber of an engine containing an insulated control electrode for conducting current
- AA. Stroke - The distance moved by the piston
- BB. Valve - A device for opening and closing the openings that admit the air and gas mixture into the cylinder.
- CC. Vapor lock - A condition whereby the fuel boils in the fuel system forming bubbles which retard or stop the flow of fuel to the carburetor

II. Machines powered by small engine

- A. Motorcycles
- B. Chain saws
- C. Mowers
- D. Outboard motors
- E. Pumps
- F. Posthole diggers
- G. Elevators

III. Operating positions (Transparency 1)

- A. Vertical
- B. Horizontal
- C. Multi-position

IV. Engines

- A. 4-cycle
 - 1. Two revolutions of crankshaft per firing

2. Lubricated from crankcase oil in the sump
- B. 2-cycle
 1. One revolution of crankshaft per firing
 2. Lubricated from oil mixed with the gasoline

V. Events of a 4-cycle engine (Transparency 2)

- A. Intake stroke
 1. Exhaust valve is closed
 2. Intake valve is open
 3. The piston moves downward and the air-fuel mixture is drawn into the cylinder
- B. Compression
 1. Intake valve closes
 2. Piston moves upward
 3. The air-fuel mixture is compressed
- C. Power
 1. Spark occurs, igniting the mixture
 2. Forces of expanding gases push the piston down
- D. Exhaust
 1. Exhaust valve opens
 2. Upward movement of piston forces the burned gases out of the cylinder
 3. Exhaust valve closes
 4. Cycle is repeated

VI. Advantages of air-cooled engines

- A. No need for complicated cooling system
- B. Lighter in weight and occupies less space
- C. Easy to repair

VII. Parts of a valve (Transparency 3)

- A. Head
- B. Margin
- C. Seat
- D. Face

- E. Stem
- V. Valve guide

VIII. Types of Valve Failure

- A. Burned - Caused by overheating and carbon particles between seat and face
- B. Necked - Caused by overheating and valve springs too strong
- C. Dished - Caused by erosion from exhaust gases

IX. Testing compression - Give the flywheel a quick spin and if it rebounds on the compression stroke, the compression is at least good enough to start the engine (Transparency 5).

X. Causes of poor compression. (Transparency 6)

- A. No compression or poor compression indicates these possibilities:
 - 1. Worn cylinder
 - 2. Worn piston rings
 - 3. Leaking gaskets
 - 4. Worn piston
 - 5. Leaking valves which can be caused by:
 - a. seats burned
 - b. valves burned
 - c. valve springs weak or broken
 - d. valve stem warped or sticking in valve guide
 - 6. Loose spark plug
 - 7. Loose cylinder head bolts
 - 8. Warped cylinder head
 - 9. Broken connecting rod
 - 10. Insufficient tappet clearance

XI. Functions of piston rings

- A. Form a gas tight seal between the piston and cylinder
- B. Helps cool the piston by transferring heat
- C. Control lubrication between piston and cylinder wall

XII. Types of piston rings (Transparency 7)

- A. Compression rings - prevent gases from leaking by the piston during the compression and power strokes.
- B. Oil control ring - is the bottom ring on the piston. Its job is to wipe the excess oil from the cylinder wall.

XIII. Primary functions of the carburetion system.

- A. To atomize the fuel
- B. Mix the atomized fuel with the proper proportion of air
- C. Vaporize the fuel-air mixture
- D. Deliver the mixture to the combustion chamber

XIV. Basic types of carburetors (Transparency 8)

- A. Natural draft
- B. Updraft
- C. Downdraft

(NOTE: Carburetor types are referred to in most small engine references as gravity feed or float-type, suction feed and pressure feed. Actually these are types of fuel delivery styles. To be consistent with the reference sources, carburetor types will be referred to in this unit as gravity feed or float type, suction lift and pressure feed.)

XV. Operation of the carburetor (Transparencies 9,10,11,12)

- A. Air enters the carburetor through the air inlet on the intake or suction stroke of the engine. As it reaches the restricted section of the air passage called the "venturi", its velocity is greatly increased. This causes fuel to be drawn out of the fuel nozzle and atomized, similar to the action of a fly sprayer. Speed control is provided by placing a flat disk called a "butterfly" in the carburetor throat above the venturi.

XVI. Parts of a float-type carburetor (Transparency 13)

- A. Fuel inlet
- B. Float needle seat
- C. Float needle
- D. Nozzle
- E. Packing nut
- F. High-speed needle valve
- G. Throttle valve
- H. Idle needle valve
- I. Venturi
- J. Float
- K. Choke valve

XVII. Small engine ignition systems

- A. Magneto system - the two most commonly used magnetos are the flywheel and the external types.
- B. Battery system - Used on garden tractors, lawn mowers and some stationary engines. Some small engines are equipped with battery and magneto ignition systems.

XVIII. Function of the ignition system

- A. To furnish a spark at the proper time which is strong enough to ignite the fuel-air mixture in the combustion chamber.

XIX. Parts of the ignition system (Transparency 14)

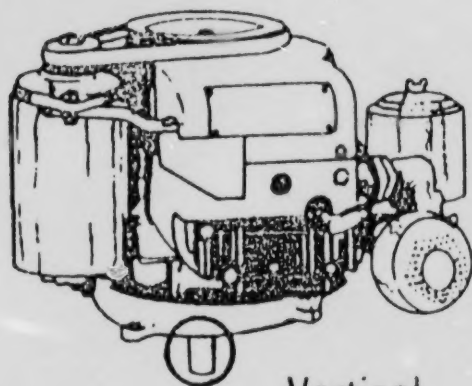
- A. Armature
- B. Coil
- C. Magnet
- D. Condenser
- E. Breaker points
- F. Spark plug

XX. Information found on name plate

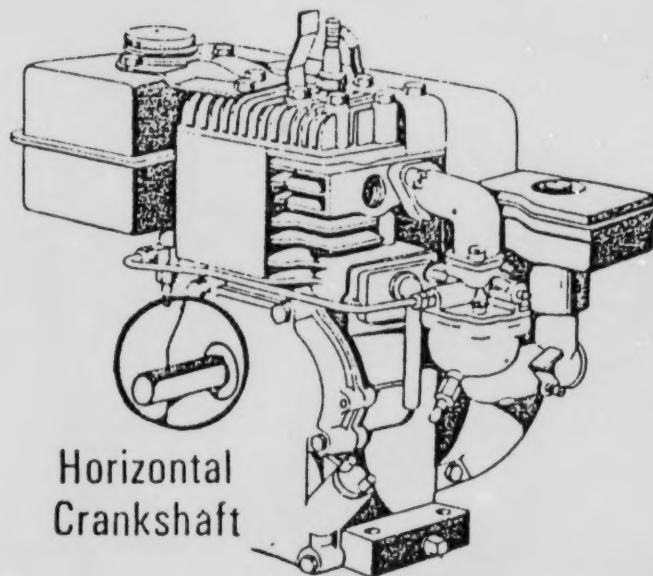
- A. Make of engine
- B. Model number
- C. Serial number
- D. Type or Specification number
- E. Code number
- F. Size



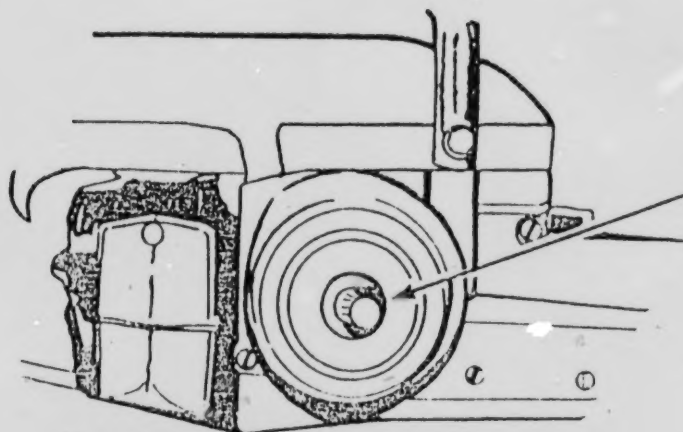
Engine Operating Positions



Vertical
Crankshaft

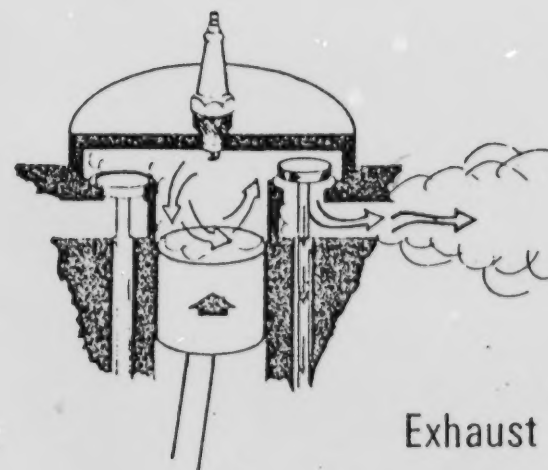
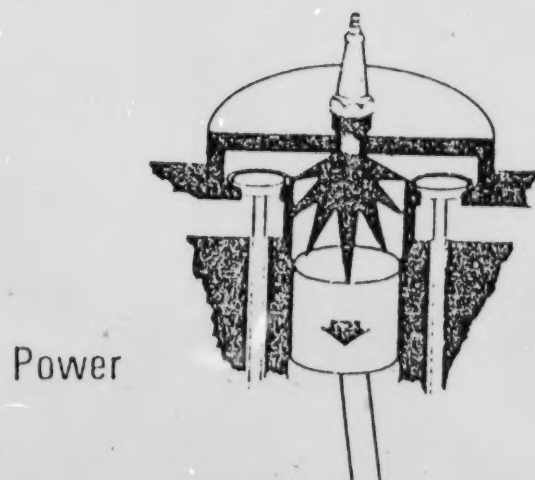
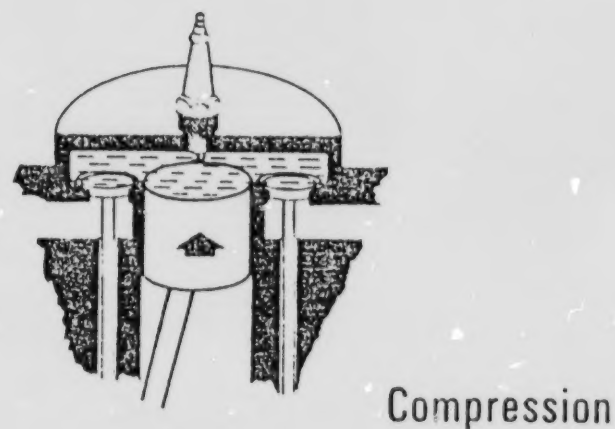
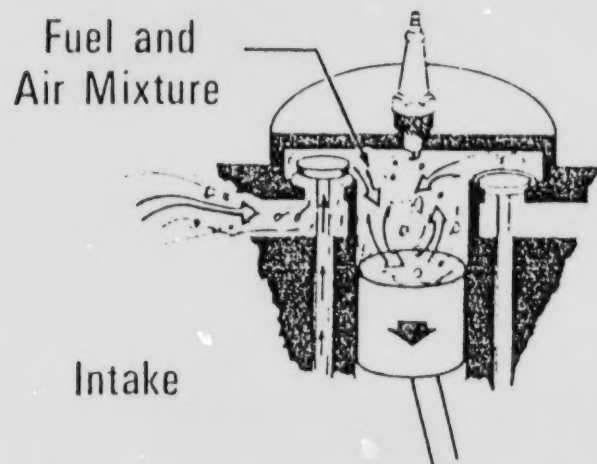


Horizontal
Crankshaft

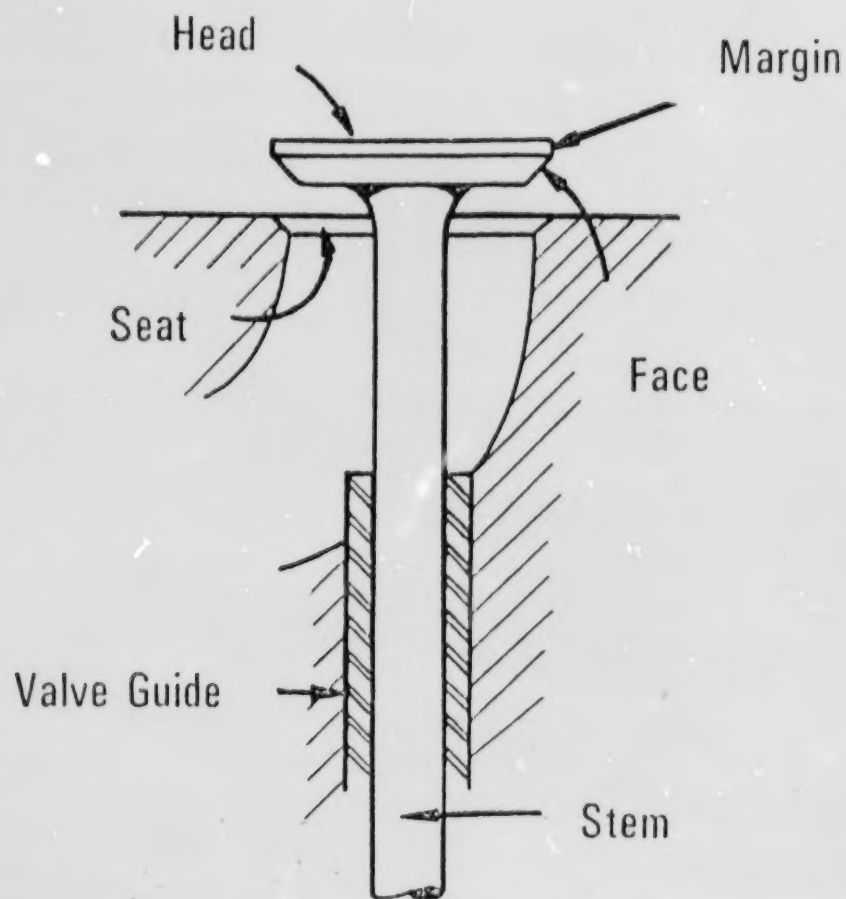


Multi-Position
Crankshaft

Principal Events in the Operating Cycle of an Engine

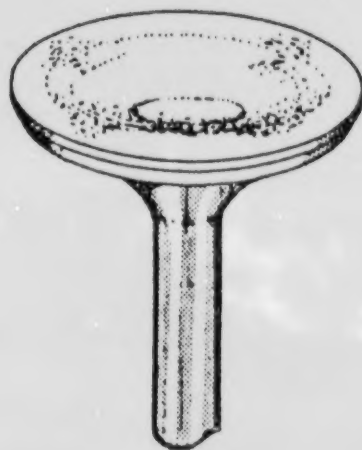
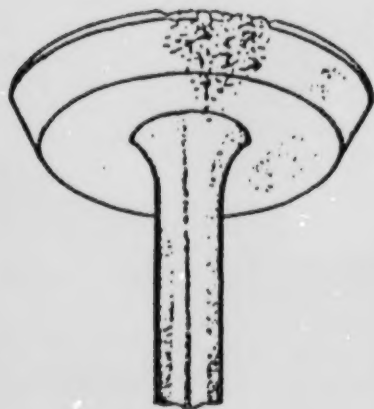


Valve Parts



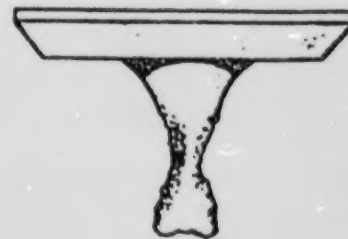
Types of Valve Failures

Burned

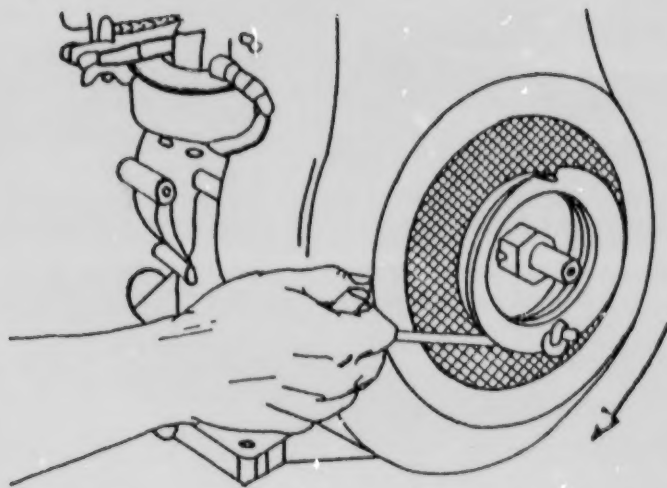


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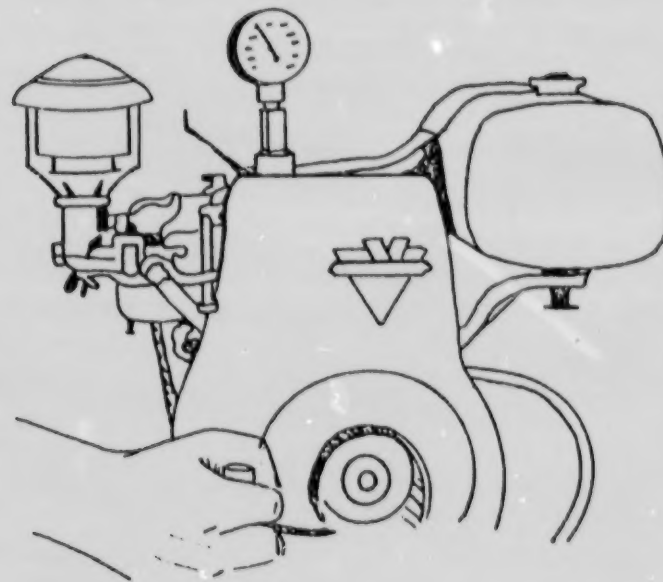
Necked



TESTING COMPRESSION



CHECK REBOUND TO CRANKING



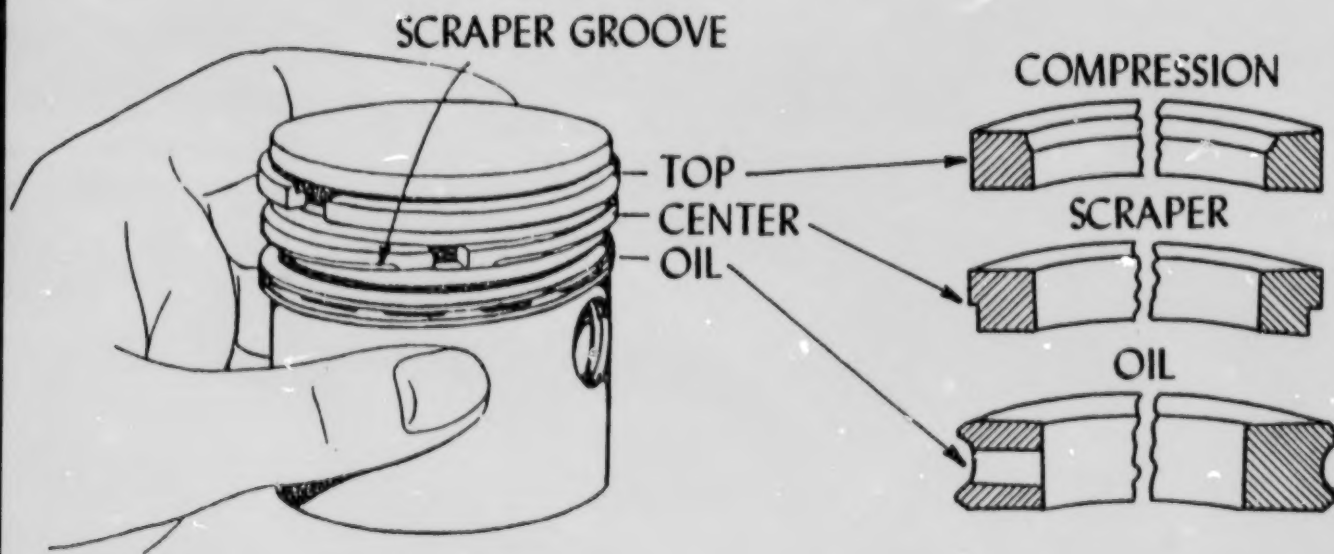
CHECK WITH COMPRESSION TESTER

CAUSES OF POOR COMPRESSION

NO COMPRESSION OR POOR COMPRESSION INDICATES THESE POSSIBILITIES:

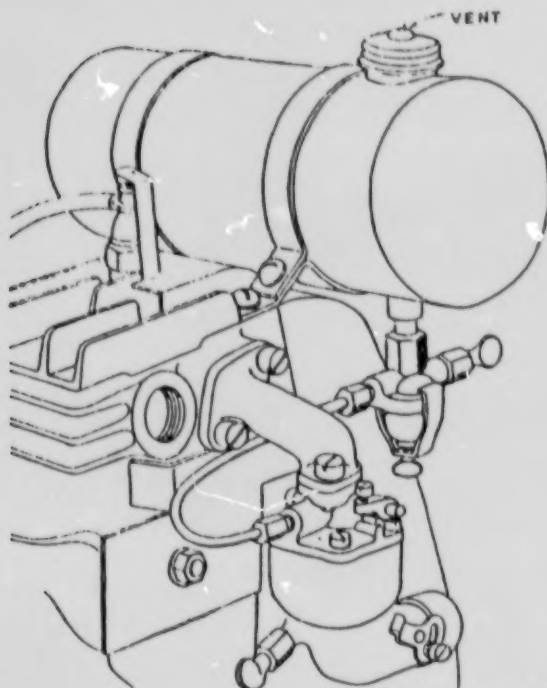
1. WORN CYLINDER
2. WORN PISTON RINGS
3. LEAKING GASKETS
4. WORN PISTON
5. LEAKING VALVES WHICH CAN BE CAUSED BY:
 - a. SEATS BURNED
 - b. VALVES BURNED
 - c. VALVE SPRINGS WEAK OR BROKEN
 - d. VALVE STEM WARPED OR STICKING IN VALVE GUIDE
6. LOOSE SPARK PLUG
7. LOOSE CYLINDER HEAD BOLTS
8. WARPED CYLINDER HEAD
9. BROKEN CONNECTING ROD
10. INSUFFICIENT TAPPET CLEARANCE

TYPES OF PISTON RINGS

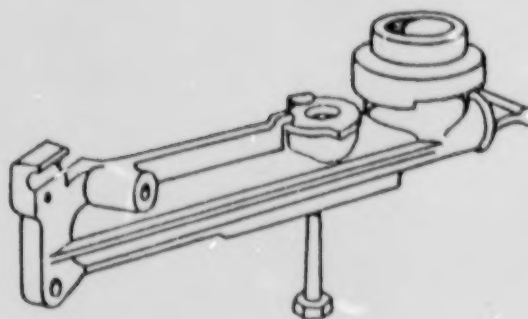


FUEL SUPPLY SYSTEMS

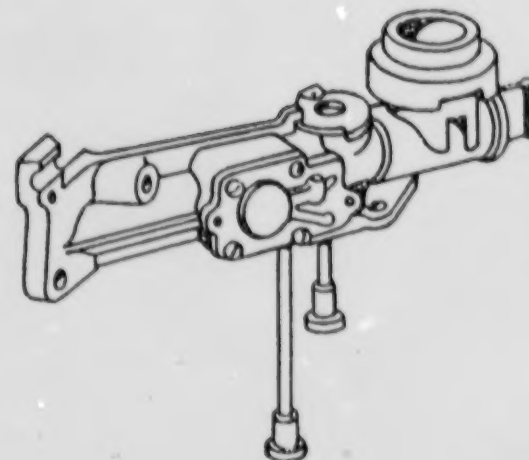
1. GRAVITY SYSTEM



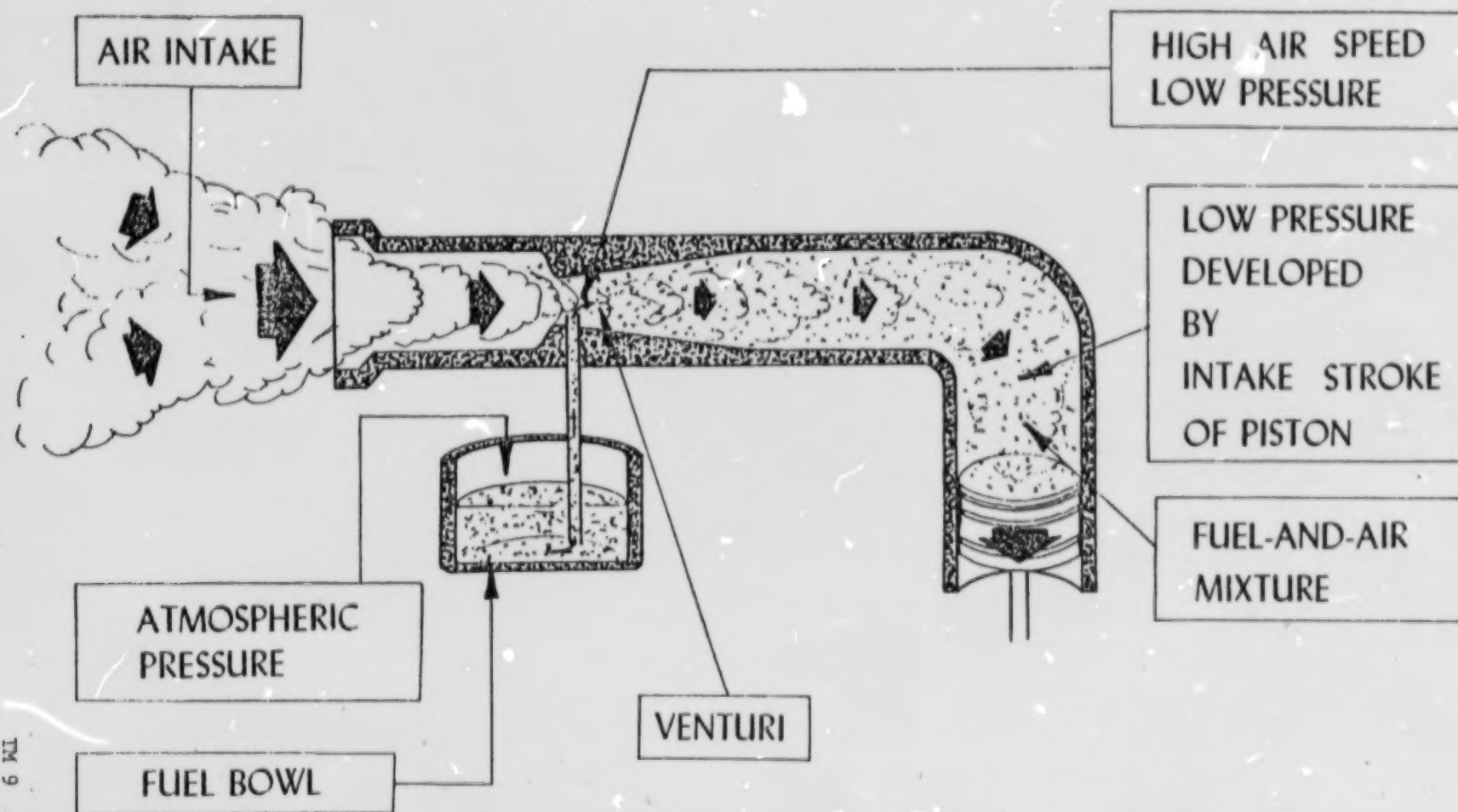
2. SUCTION SYSTEM



3. PUMP SYSTEM

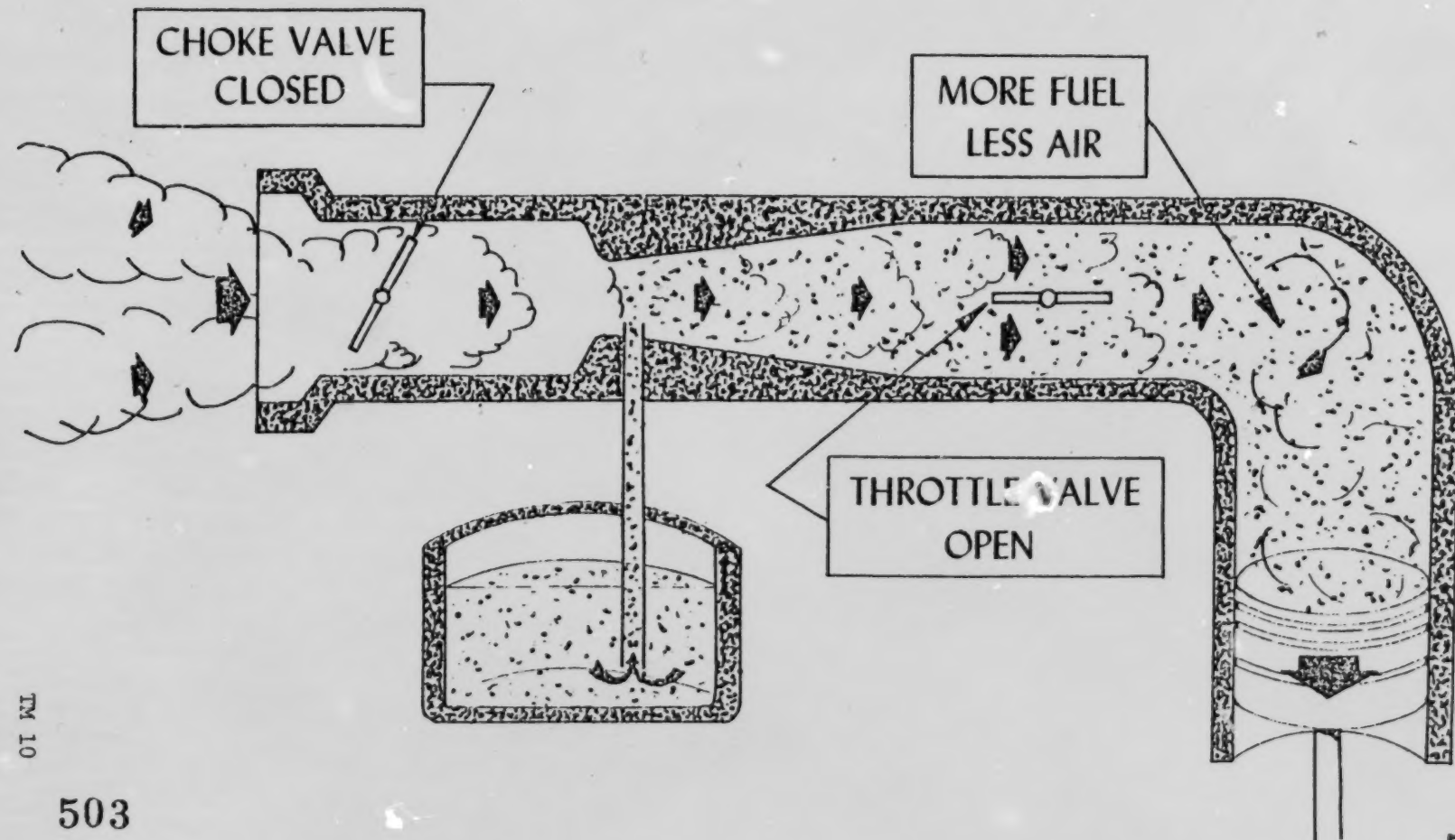


CARBURETOR OPERATING PRINCIPLE (4-CYCLE ENGINES)



6 M
9

CARBURETOR CHOKE VALVE

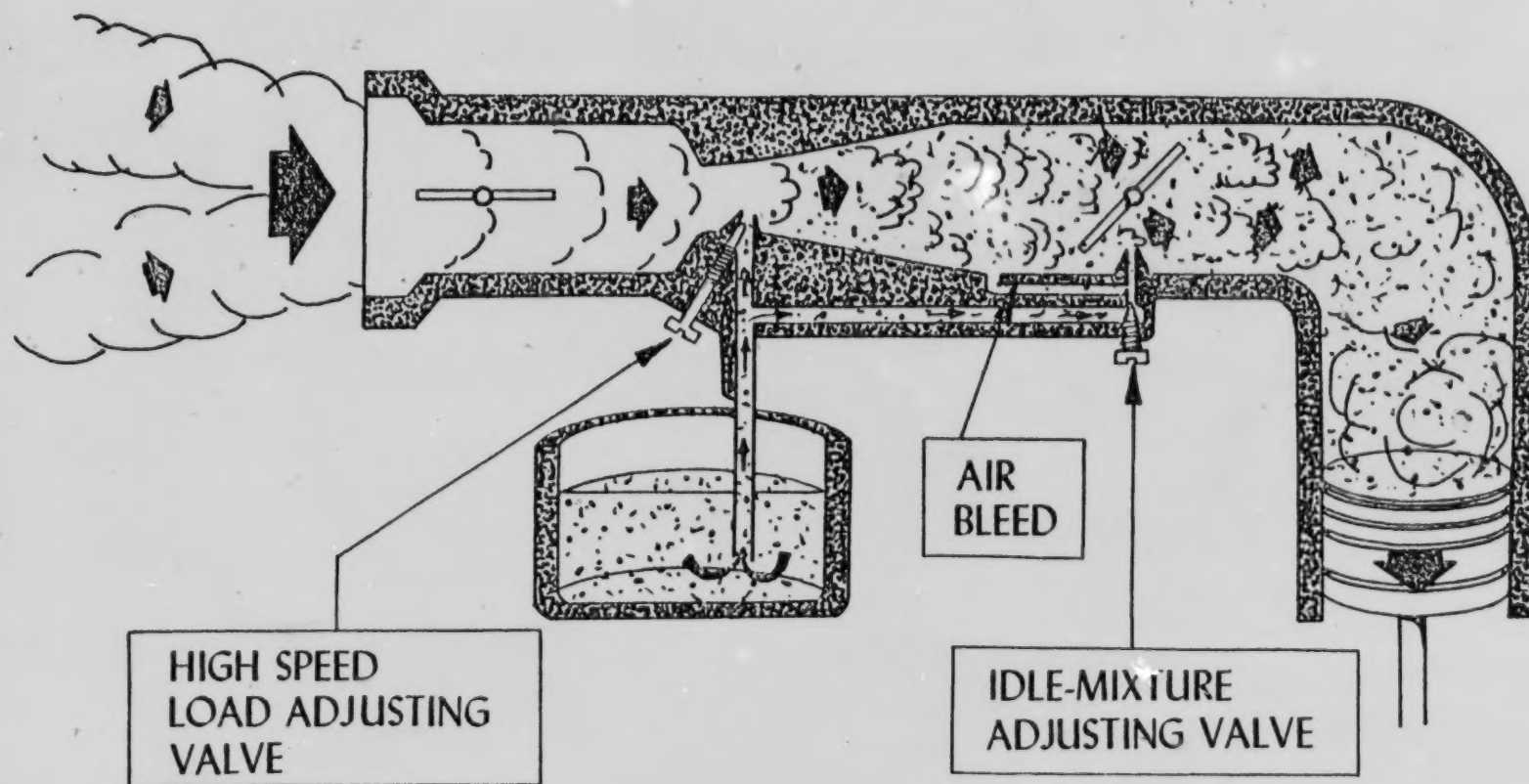


TM 10

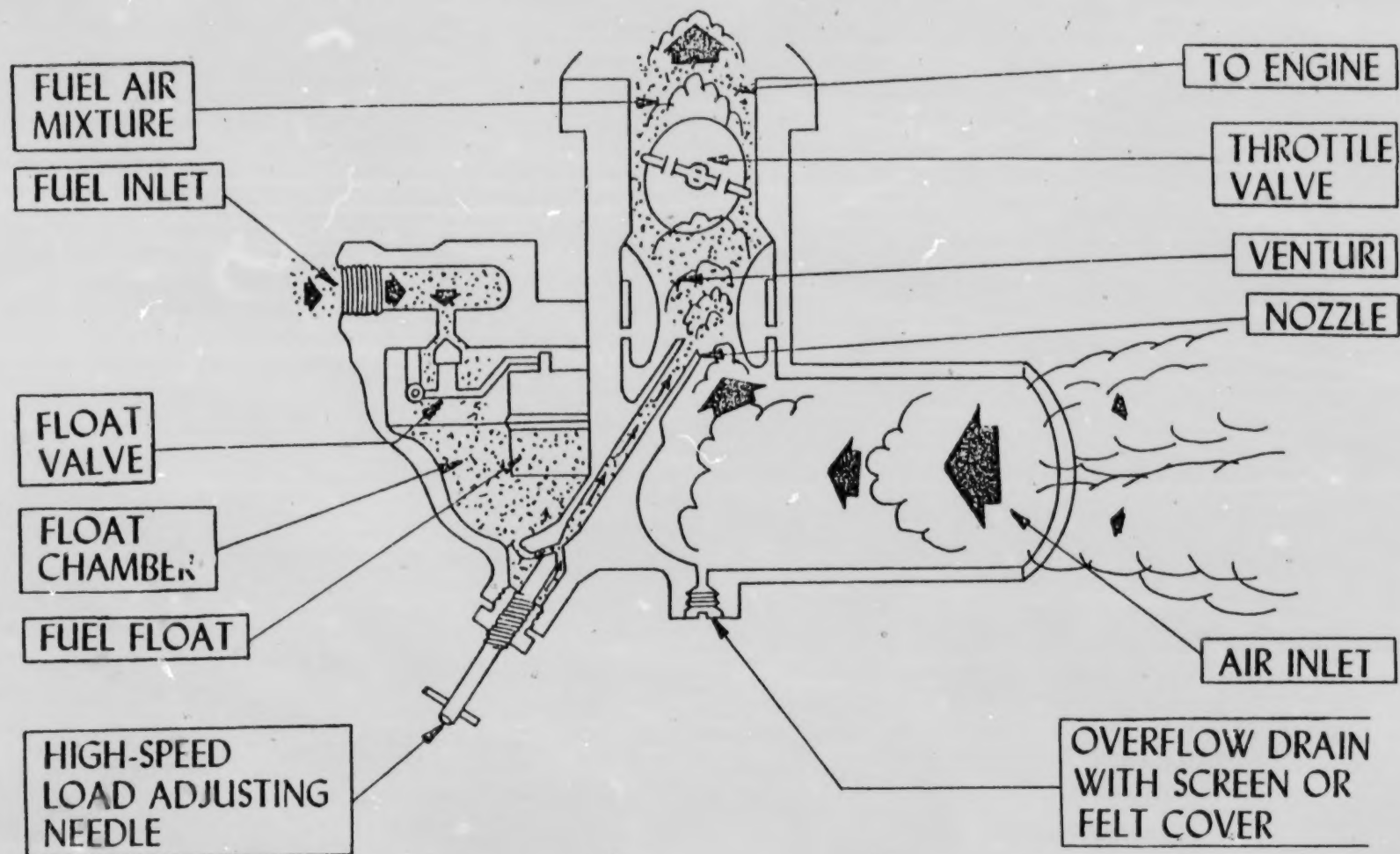
503

504

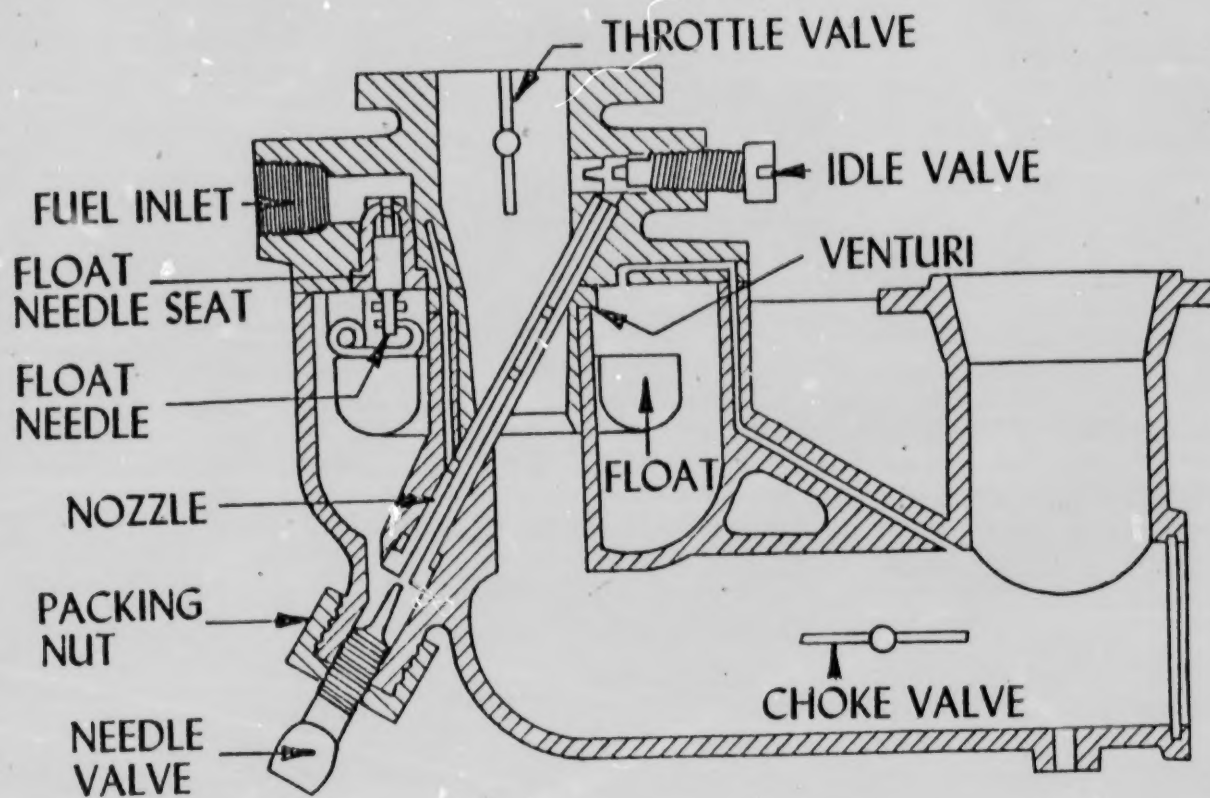
CARBURETOR ADJUSTING VALVE



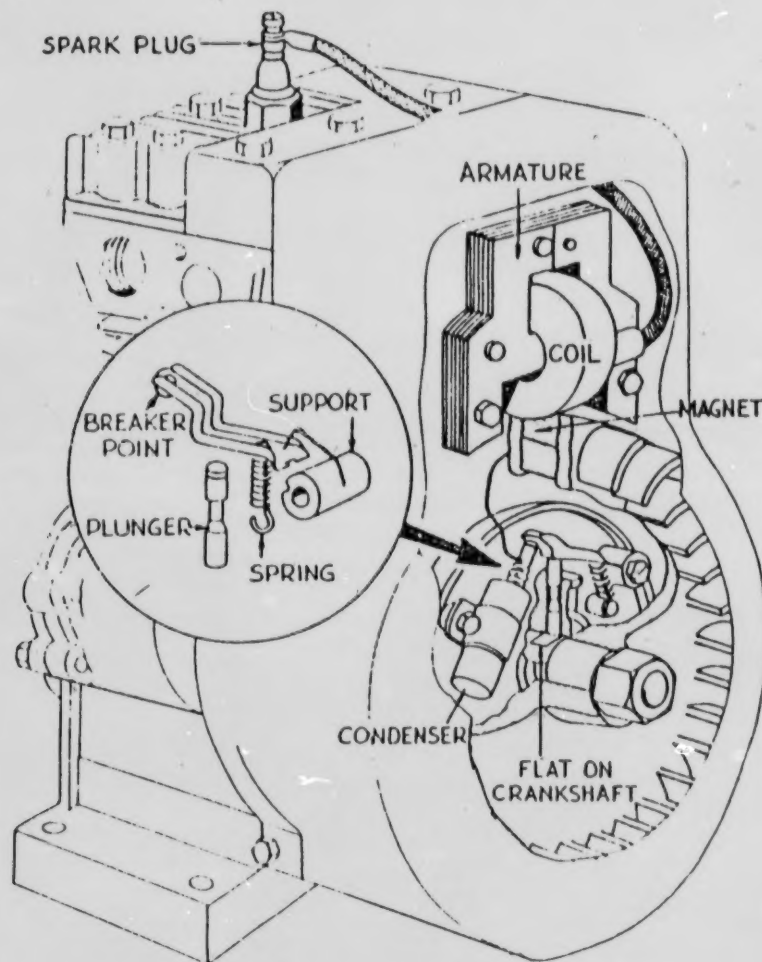
FLOAT-TYPE CARBURETOR (CONSTANT LOAD AND SPEED)



PARTS OF FLOAT CARBURETOR



PARTS OF MAGNETO IGNITION SYSTEM



ENGINE OPERATION
UNIT IX

ASSIGNMENT SHEET #1 - Engine Inspection Chart

Engine: Make _____ Model _____ Serial No. _____

Type or Specification No. _____ Code No. _____ Horsepower _____

Operating Position of Crankshaft: Vertical _____, Horizontal _____, Multi-Position _____

Engine Cycle: 2-Cycle _____, 4-Cycle _____

TYPES OF ACCESSORIES AND MAJOR UNITS:

CARBURETOR AIR CLEANER: Oil bath ☐ Oiled filter ☐ Dry filter ☐

FUEL STRAINER: Combination screen and sediment bowl ☐ Screen inside
the fuel tank ☐

CRANKCASE BREATHER: Reed valve ☐ Floating disk valve ☐

STARTER: Rope-wind Rope-rewind ☐ Wind up ☐ Electric, AC ☐
Electric, DC ☐

IGNITION SYSTEM: Magneto ☐ Battery ☐

FUEL PUMP: Mechanically driven ☐ Diaphragm

CARBURETOR: Float ☐ Suction ☐ Diaphragm ☐

GOVERNOR: Air vane ☐ Mechanical ☐

ASSIGNMENT SHEET #1

ITEM		Standard	Actual	Recommendation	Parts No.
SPARK PLUG GAP					
ARMATURE AIR GAP					
TAPPET CLEARANCE Intake					
Exhaust					
BREAKER POINT GAP					
BREAKER POINT PLUNGER HOLE		Use go, no go gauge			
CRANKSHAFT END PLAY					
CYLINDER	Diameter				
	Out of Round	0			
	Taper	0			
VALVE GUIDE		Use go, no go gauge			
MAIN BEARINGS Magneto Journal		Use go, no go gauge			
P.T.O Journal		Use go, no go gauge			
RING GROOVE SIDE CLEARANCE					
RING END GAP Compression					
Oil					
CRANKSHAFT	Magneto Journal				
Diameter	Crankpin				
P.T.O. Journal					
Magneto Journal		0			
Out of Round	Crankpin	0			
P.T.O. Journal		0			
VALVE MARGIN		1/32"			

ENGINE OPERATION
UNIT IX

JOB SHEET #1 - Disassemble a Small Gasoline Engine

I. Tools and materials needed

- A. 4-cycle engine
- B. 3/8" drive socket set
- C. Combination wrench set
- D. Standard screwdriver
- E. Soft mallet
- F. Adjustable wrench
- G. Punches
- H. Ring compressor
- I. Flywheel puller
- J. Starter wrench
- K. Flywheel holder
- L. Spring compressor
- M. Container for holding parts

II. Procedure

- A. Drain oil
- B. Remove air cleaner stud and wing nut
- C. Remove fuel line
- D. Remove carburetor and linkage
- E. Remove carburetor intake elbow
- F. Remove muffler if necessary
- G. Check space between carburetor bodies on two-piece carburetor
- H. Remove shroud and check rewind starter
- I. Check compression
- J. Remove spark plug and measure gap
- K. Check air gap, armature to flywheel
- L. Remove governor blade
- M. Remove breather assembly
- N. Remove cylinder head and shield

ENGINE OPERATION
UNIT IX

JOB SHEET #2 - Checking Coils and Condensors

I. Tools and equipment needed

- A. Coil
- B. Condensor
- C. Coil-Condensor Tester

II. Procedure

(NOTE: The following procedure is based on a Graham-Lee coil-condensor tester. Other testers are similar.)

A. Condensor Test

- 1. Connect the AC power cord.
- 2. Attach red clip to primary wire and the black clip to the case.
- 3. Turn tester "OFF-ON" switch to "ON" position
 - a. Good condensor - Continuity light will glow briefly and go out.
 - b. Bad condensor - Continuity light glows continuously
- 3. Turn "OFF-ON" switch to "OFF" position before disconnecting test clips. (Discharges condensor.)

B. Coil Continuity Tests

- 1. Connect AC power cord
- 2. Connect red clip to primary wire and black clip to ground wire
- 3. Turn switch to "ON" position. Continuity light should glow continuously
- 4. Turn switch "OFF"
- 5. Remove black clip from coil ground wire and connect to the secondary wire (sparkplug wire).
- 6. Turn switch "ON". Continuity light should glow continuously
- 7. Turn switch "OFF"

C. Coil Power Output Test

- 1. Connect AC power cord
- 2. Connect red clip to coil primary and black clip to cord ground wire.
- 3. Connect coil secondary wire to "SPARK GAP TESTER"
- 4. Turn switch "ON" and then turn spring loaded "TEST SELECTOR" switch to "COIL TEST" and hold while turning "COIL INDEX" switch clockwise until current crosses the spark gap.

- O. Check tappet clearance
- P. Remove valves and springs
- Q. Remove starter pulley or clutch
- R. Remove flywheel
- S. Remove breaker point cover
- T. Check contact point gap
- U. Remove breaker points and check plunger hold
- V. Check and play
- W. File burrs from crankshaft power take-off end
- X. Remove base or sump
- Y. Remove oil slinger and bracket
- Z. Remove cam gear
- AA. Remove tappets
- BB. Remove connecting rod and piston
- CC. Remove crankshaft
- DD. Remove piston from connecting rod

(NOTE: If index setting is over "60" refer to specifications book to see if allowable "Gap Index" setting has been exceeded.)

5. Turn switch "OFF"

ENGINE OPERATION
UNIT IX

JOB SHEET #3 - Checking Cylinder Bore

I. Tools and equipment needed

- A. Cylinder
- B. Telescoping gauge
- C. Outside micrometer
- D. Rags

II. Procedure

- A. Clean cylinder thoroughly
- B. Give visual inspection
 - 1. Cracks
 - 2. Broken studs or bolts
 - 3. Stripped threads
 - 4. Broken fins
 - 5. Scored cylinder wall
- C. Check cylinder for taper and out of round
 - 1. Be sure cylinder is clean
 - 2. Use telescoping gauge and micrometer to determine cylinder size
 - 3. Measure at right angles (See Figure 1)
 - 4. Consult service manual for standard bore diameter and allowable wear limitations

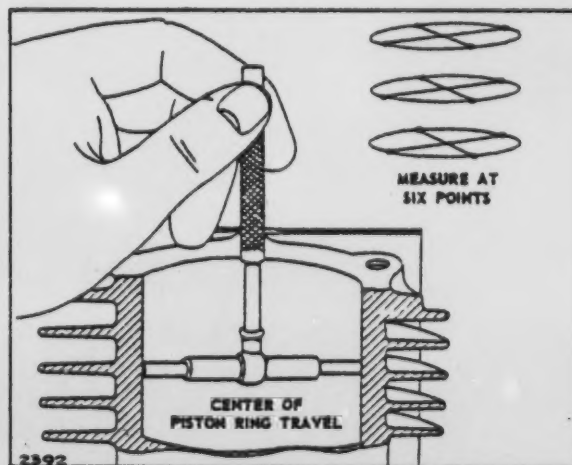


Fig. 1 - Check Cylinder Bore

ENGINE OPERATION
UNIT IX

JOB SHEET #4 - Checking Valve Guides and Crankcase Bearings

I. Tools and equipment needed

- A. Small engine crankcase
- B. Telescoping gauge
- C. Ball gauge
- D. Outside micrometers
- E. Appropriate plug gauges

II. Procedure

(NOTE: The procedure for checking guides and bearings requires the use of special plug gauges for B & S engines while others can be checked with the other listed tools.)

A. Checking Valve Guides

- 1. Clean valve guides
- 2. Check diameter at top of guide with ball gauge and micrometer or recommended plug gauge.
- 3. See engine service manual for specifications

(NOTE: If guides are worn beyond limitations, most can be reamed to an oversize and rebushed.)

B. Checking Crankcase Bearings

- 1. Clean bearings
- 2. Give visual inspection
 - a. Scoring
 - b. Scratches
- 3. Check bearings for wear using telescoping gauges and a micrometer or the recommended plug gauge
- 4. Check at right angles
- 5. See engine service manual for standards and wear limits

(NOTE: Crankcase bearings can be reamed and rebushed in most cases. However, this requires special equipment and the decision should be based on overall engine condition.)

ENGINE OPERATION
UNIT IX

JOB SHEET #5 - Checking Piston Rings, Piston Pins and Rod

I. Tools and equipment needed

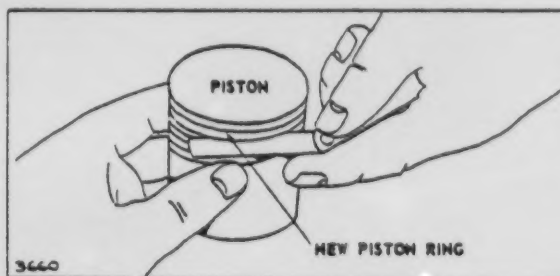
- A. Micrometers
- B. Ball gauges
- C. Telescoping gauges
- D. Thickness gauge
- E. Torque wrench, 0-200 inch pounds

II. Procedure

A. Checking pistons

- 1. Clean the piston, including the ring grooves
- 2. Give visual inspection
 - a. Obvious wear
 - b. Scoring
- 3. Place NEW ring in top ring groove and check side clearance. See manufacturers specifications and Figure 1.

Figure 1



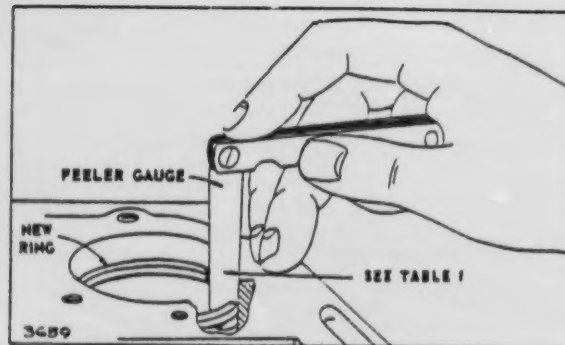
B. Checking rings

- Checking Ring Grooves

- 1. Clean the rings as needed
- 2. Examine for presence of scuffing or scoring
- 3. Check for wear
 - a. Insert ring into cylinder just below ring groove or travel point
 - b. Check gap with thickness gauge (See Figure 2)

4. See manufacturers specifications for wear limitations

Figure 2



- Checking Ring Gap

- C. Checking piston pin
 1. Clean piston pin
 2. Using a micrometer, check the piston pin for wear. See manufacturers specifications for allowable tolerance
 - D. Checking connecting rod
 1. Clean connecting rod
 2. Visual inspection
 - a. Cracks
 - b. Distortion or twisting
 - c. Scored bearing surface
 3. Using ball gauges, check piston pin hole diameter
 4. Align match marks and install rod cap to rod, torque to correct tension
 5. Using telescoping gauges and micrometer measure the diameter of the bearing
- (NOTE: Check all measurements against the manufacturers specifications.)

ENGINE OPERATION
UNIT IX

JOB SHEET #6 - Refacing Valves and Valve Seats

I. Tools and equipment needed

- A. Valve refacer
- B. Suction cup
- C. Lapping compound
- D. Valve seat cutters
- E. Rag
- F. Micrometer, 0-1"

II. Procedure

(NOTE: Always check the manufacturers specifications for correct angles, margins, and valve seat width.)

A. Valve refacing

- 1. Clean deposits from valve with wire wheel
- 2. Visual inspection
 - a. Burned or pitted face
 - b. Thin margin (see engine specifications)
 - c. Bent valve
 - d. Worn stem
 - e. Grooved valve face
- 3. Measure valve stem for wear
- 4. Refinish valve face
 - a. Grind - if grooved, pitted or burned
 - b. Lap - if smooth and after grinding
- 5. Recheck valve margin
- 6. Clean lapping compound from valve

B. Valve seat refinishing

- 1. Clean seats, guides and valve parts
- 2. Visual inspection
 - a. Pitting and burning
 - b. Loose seat
 - c. Wide seat
 - d. Rounded seat

3. Refinish valve seat
 - a. Grind or cut - if pitted, burned or rounded
 - b. Lap - if smooth and after grinding or cutting
4. Check seat width and narrow if necessary
5. Clean lapping compound from valve seat and port area

ENGINE OPERATION
UNIT IX

JOB SHEET #7 - Reassemble a Small Gasoline Engine

I. Tools and materials needed

- A. 3/8" drive socket set
- B. Combination wrench set
- C. Standard screwdriver
- D. Soft mallet
- E. Adjustable wrench
- F. Punch
- G. Ring compressor
- H. Starter wrench
- I. Flywheel holder
- J. Spring compressor

II. Procedure

- A. Install crankshaft
- B. Assemble piston pin and connecting rod
- C. Assemble rings to piston
- D. Install piston and connecting rod assembly
- E. Install tappets
- F. Install cam gear
- G. Install oil slinger, gear, and bracket
- H. Install base or sump with gasket
- I. Check and adjust tappet clearance
- J. Check and adjust valves, springs and retainers
- K. Check and adjust crank breather cover
- L. Check and adjust end play
- M. Install coil and governor blade
- N. Install points, adjust gap, and clean
- O. Install and seal point cover

- P. Install flywheel
- Q. Adjust armature air gap
- R. Install carburetor
- S. Install shrouding and rest of sheet metal

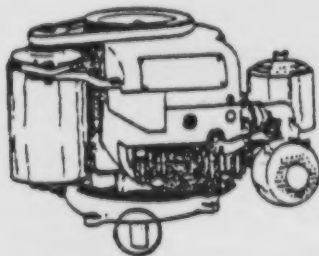
ENGINE OPERATION
UNIT IX

TEST

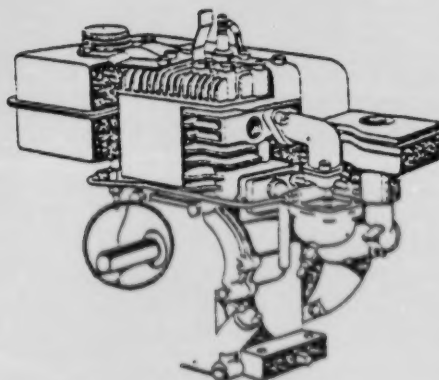
1. Define the following terms.
 - a. Score-
 - b. Stroke-
 - c. Spark plug-
 - d. Cylinder block-
 - e. Carburetor-

2. List five machines that are powered by a small gasoline engine.
 - a.
 - b.
 - c.
 - d.
 - e.

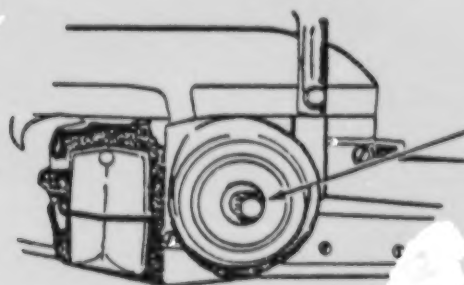
3. Identify the operating position of each engine from the drawings below.



a. _____



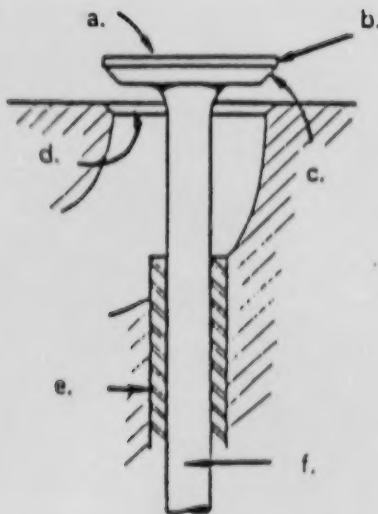
b. _____



c. _____

4. What is the difference between a 4-cycle and a 2-cycle engine?
5. Name and describe the four principal events in the operation of a 4-cycle engine.
 - a.
 - b.
 - c.
 - d.
6. Name three advantages of an air-cooled engine.
 - a.
 - b.
 - c.

7. Identify the valve parts.



- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____

8. Identify the following types of valve failures.



- a. _____



b. _____



c. _____

9. Describe one way of making a very simple compression test?

10. List five things that can cause poor compression.

a. _____

b. _____

c. _____

d. _____

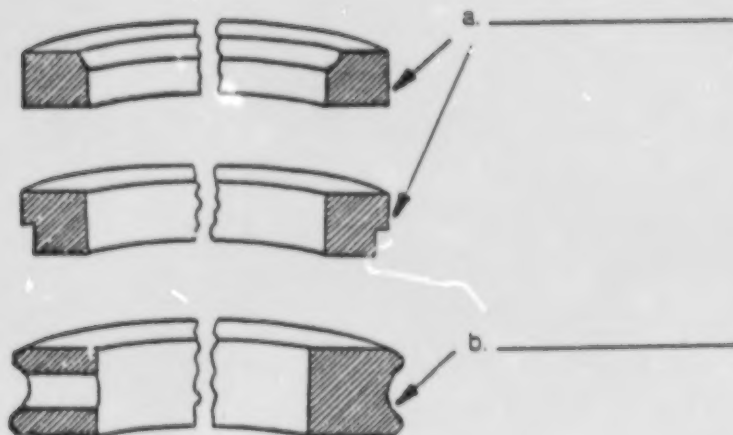
e. _____

11. What is the primary function of the following piston rings?

a. Compression rings-

b. Oil control ring-

12. Identify the types of piston rings.



13. Name two primary functions of the carburetion system.

a. _____

b. _____

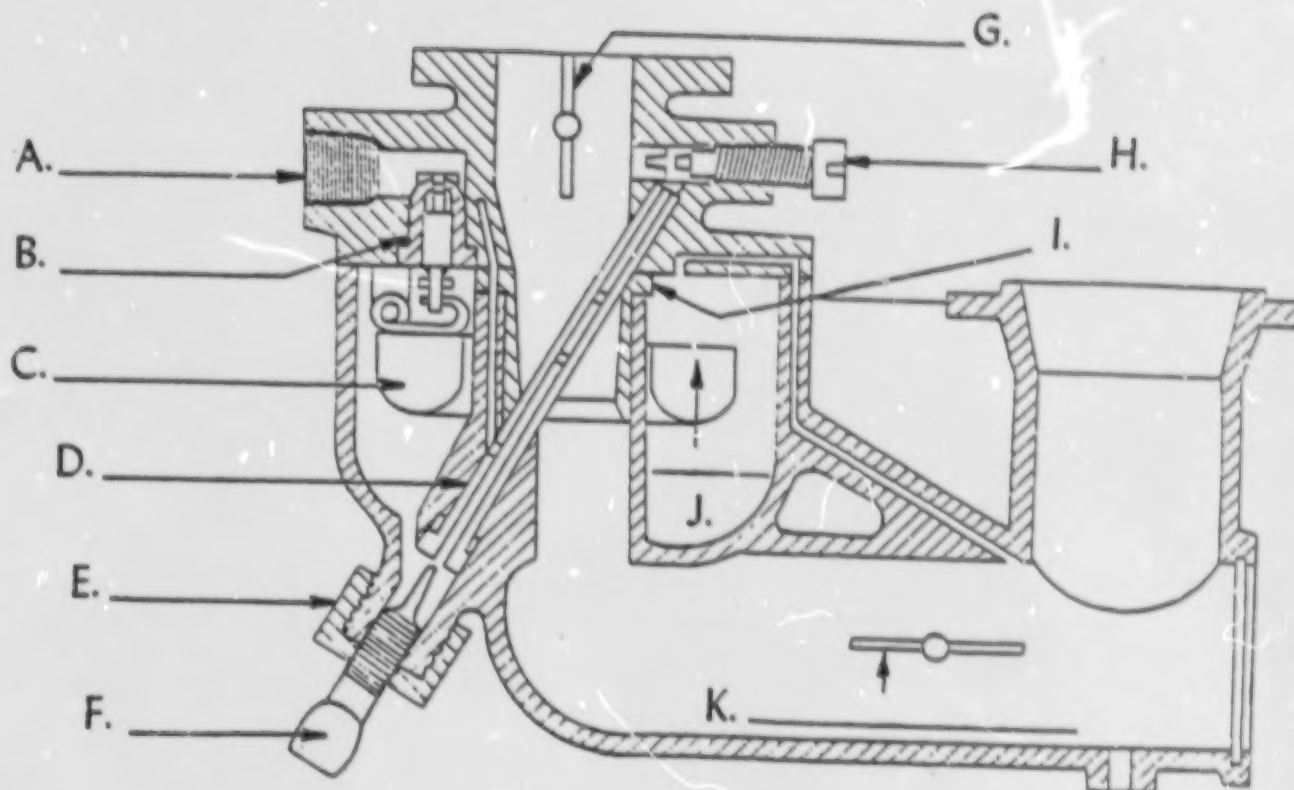
14. List two basic types of small engine carburetors.

a. _____

b. _____

15. What is the purpose of the restricted section (venturi) in the carburetor air passage?

16. Identify the carburetor parts.



17. What are the two most commonly used magneto systems found on small engines?

a. _____

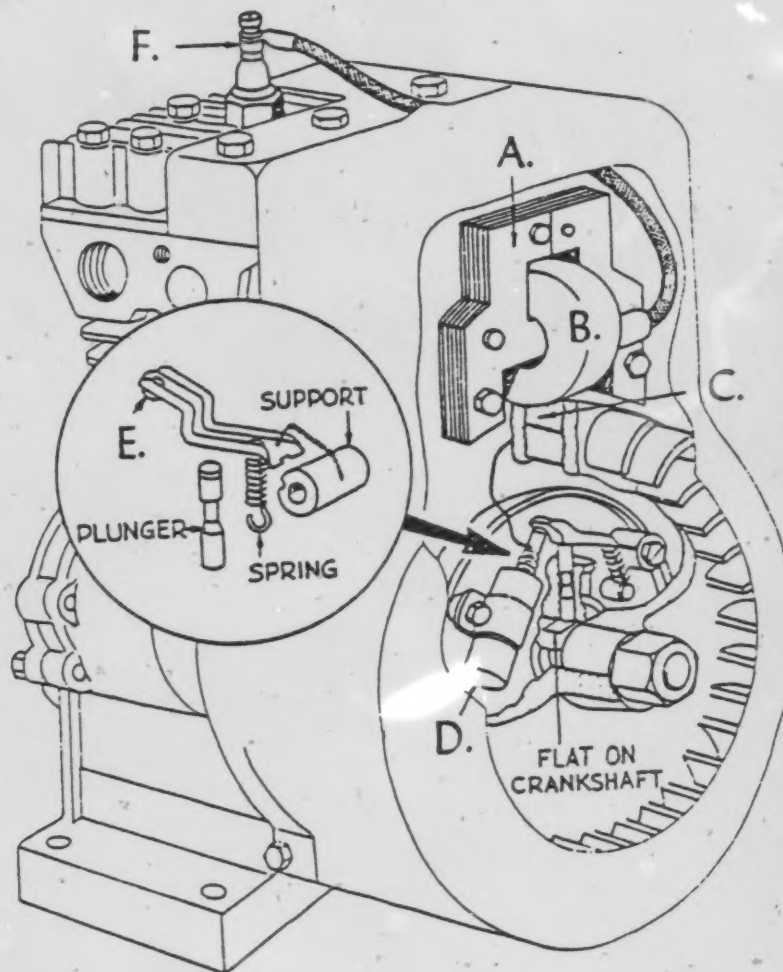
b. _____

18. What is the function of the ignition system?

- a. _____

19. Identify the magneto parts.

- a. _____
b. _____
c. _____
d. _____
e. _____
f. _____



20. Demonstrate the ability to:

- a. Disassemble a small gasoline engine.
b. Reassemble a small gasoline engine.

ENGINE OPERATION
UNIT IX

ANSWERS TO TEST

1.
 - a. A scratch, ridge, or groove marring a finished surface.
 - b. The distance moved by the piston.
 - c. A device inserted into the combustion chamber of an engine containing an insulated control electrode for conducting current.
 - d. The largest single part of an engine; the basis or main mass of metal in which the cylinders are bored or placed.
 - e. A device for automatically mixing fuel in the proper proportion with air to produce a combustible gas.
2. Any five of the following:
 - a. Motorcycles
 - b. Chain saws
 - c. Mowers
 - d. Outboard motors
 - e. Pumps
 - f. Posthole diggers
 - g. Elevators
3.
 - a. Vertical
 - b. Horizontal
 - c. Multi-position
4.
 - a. 4-cycle, two revolutions of crankshaft per firing, lubricated from crankcase oil in the sump
 - b. 2-cycle, one revolution of crankshaft per firing, lubricated from oil mixed with the gasoline.
5.
 - a. Intake-exhaust valve is closed; intake valve is open; piston moves downward and the air-fuel mixture is drawn into the cylinder.
 - b. Compression-intake valve closes; piston moves upward; air fuel mixture is compressed.

- c. Power-spark occurs, igniting the mixture; forces of expanding gases push the piston down.
 - d. Exhaust-exhaust valve opens; upward movement of piston forces burned gases out of cylinder; exhaust valve closes; cycle is repeated.
- 6.
- a. No need for complicated cooling system.
 - b. Lighter in weight and occupies less space.
 - c. Easy to repair.
- 7.
- a. Head
 - b. Margin
 - c. Face
 - d. Seat
 - e. Valve guide
 - f. Stem
- 8.
- a. Necked
 - b. Burned
 - c. Dished
9. Give the flywheel a quick spin, and if it rebounds on the compression stroke, the compression is at least good enough to start the engine.
10. Any five of the following:
- a. Worn cylinder
 - b. Worn piston rings
 - c. Leaking gaskets
 - d. Worn piston
 - e. Leaking valves
 - f. Loose spark plug
 - g. Loose cylinder head
 - h. Warped cylinder head
 - i. Broken connecting rod
 - j. Insufficient tappet clearance

11.
 - a. Compression rings prevent gases from leaking by the piston during the compression and power strokes.
 - b. Oil control ring wipes the excess oil from the cylinder wall.
12.
 - a. Compression rings
 - b. Oil control ring
13. Any two of the following:
 - a. Atomize the fuel
 - b. Mix atomized fuel with the proper proportion of air
 - c. Vaporize the fuel-air mixture
 - d. Deliver the mixture (fuel-air) to the combustion chamber
14. Any two of the following:
 - a. Gravity feed, float-type
 - b. Suction
 - c. Pressure
15. Increases the air velocity causing fuel to be drawn out of the fuel nozzle and atomized.
16.
 - a. Fuel inlet
 - b. Float needle seat
 - c. Float needle
 - d. Nozzle
 - e. Packing nut
 - f. High-speed needle valve
 - g. Throttle valve
 - h. Idle needle valve
 - i. Venturi
 - j. Float
 - k. Choke valve

17.
 - a. Flywheel types
 - b. External types
18. To furnish a spark at the proper time which is strong enough to ignite the fuel-air mixture in the combustion chamber.
19.
 - a. Armature
 - b. Coil
 - c. Magnet
 - d. Condenser
 - e. Breaker points
 - f. Spark plug
20. Performance skills will be evaluated by the instructor.

FARM FUELS
UNIT XII

TERMINAL OBJECTIVE

After completion of Unit XII, the student should be able to match terms associated with farm fuels, describe the important characteristics of farm fuels, discuss maintenance of farm fuel quality through sound handling and storage practices, and score eighty-five percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able to:

1. Match five terms associated with farm fuels when given the proper definition.
2. List three types of farm fuel.
3. Identify five important qualities of farm fuels.
4. Discuss in a short paragraph four factors to consider when storing farm fuels.

FARM FUELS
UNIT XII

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheet.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheets.
- F. Give test.

II. Student:

- A. Read objectives.
- B. Study information sheets.
- C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
 - 1. TM 1 - Above Ground Storage for Fuel
 - 2. TM 2 - Proper Installation of an LP-Gas Storage Tank
 - 3. TM 3 - Comparison of Evaporation Rates of Gasoline Stored in 55 Gallon Tanks
 - 4. TM 4 - Comparison of Evaporation Rates of Gasoline Stored in 300 Gallon Tanks
 - 5. TM 5 - Proper Installation of an Above Ground Storage Tank
 - 6. TM 6 - Proper Installation of an Underground Storage Tank
- D. Assignment sheet
 - 1. Assignment Sheet #1 - Identifying Farm Fuels
- E. Answers to assignment sheet
- F. Test
- G. Answers to test

II. References:

- A. Fundamentals of Service Manual, Fuels, Lubricants and Coolants by Deere and Company.

FARM FUELS
UNIT XII

INFORMATION SHEET

I. Terms and definitions

- A. Compression ratio - Ratio between total volume inside the engine cylinder when the piston is at its greatest distance from the cylinder head compared to the volume when the piston has traveled closest to the cylinder head
- B. Octane rating - Method of comparing the antiknock qualities of fuels used in spark ignition engines.
- C. Volatility - the ability of a fuel to vaporize easily.
- D. Gum - deposits left in gas containers as the gasoline evaporates.
- E. Additives - Compounds added to fuels to increase its performance.
- F. LP Gas - Liquefied petroleum gas
- G. Cetane number - Method of comparing antiknock qualities of diesel fuel.

II. Types of Farm Fuels

- A. Gasoline - used in all spark ignition engines.
- B. Diesel Fuel
 - 1. Grade No. 1-D - used in high speed engines with variations in load and speed. Also, where abnormally low fuel temperatures are encountered.
 - 2. Grade No. 2-D - used in engines with high loads and uniform speeds. Also, where air temperatures are warm.
- C. LP Gas
 - 1. Propane
 - 2. Butane
 - 3. Combination of propane and butane

III. Important qualities of farm fuels

- A. Proper octane or proper cetane rating
- B. Easy starting
- C. High oxidation stability and freedom from gum
- D. Freedom from foreign matter, including water and dirt
- E. Use of fuel additives

IV. Factors to consider when storing fuel

A. Protection of fuel quality (Transparency 1 and 2)

1. Control loss through evaporation (TM 3,4)
2. Avoid gum deposits
3. Protect from water and dirt
4. Keep tank full
5. Use white or aluminum painted tank
6. Slope tank from fuel pickup hose to back of tank

B. Safety

1. Above ground tank (TM 5)
 - a. locate at least 40 feet from closest building
 - b. supported on well built racks
2. Underground tank (TM 6)
 - a. can be located as close as one foot from wall
 - b. place in well drained area
 - c. ground should slope from pump

C. Convenience

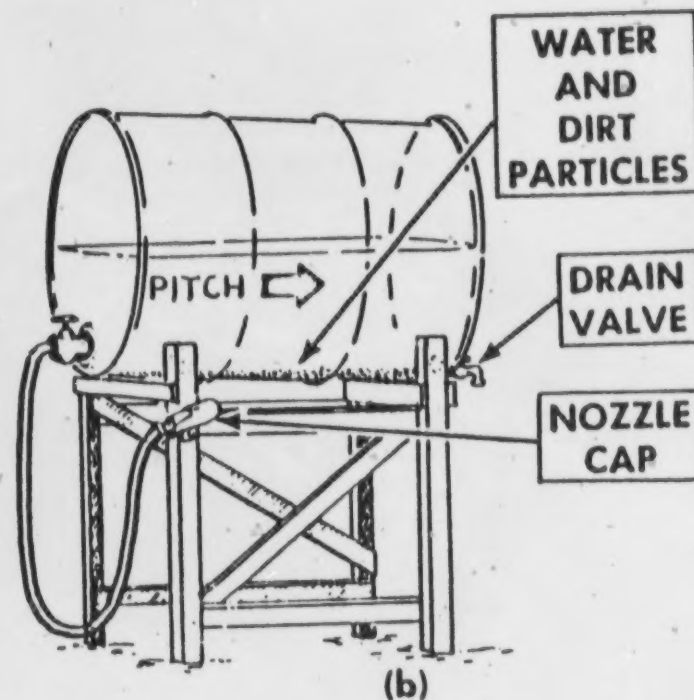
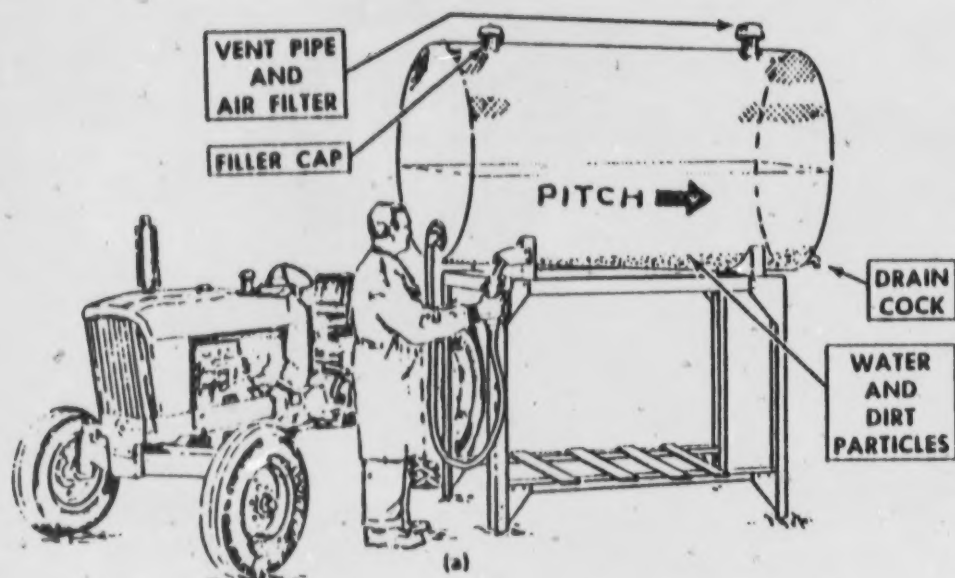
1. Allow 50 feet on one side of above ground storage tank or pump for maneuvering
2. Select either above or below ground storage tank

D. Cost - consider the following

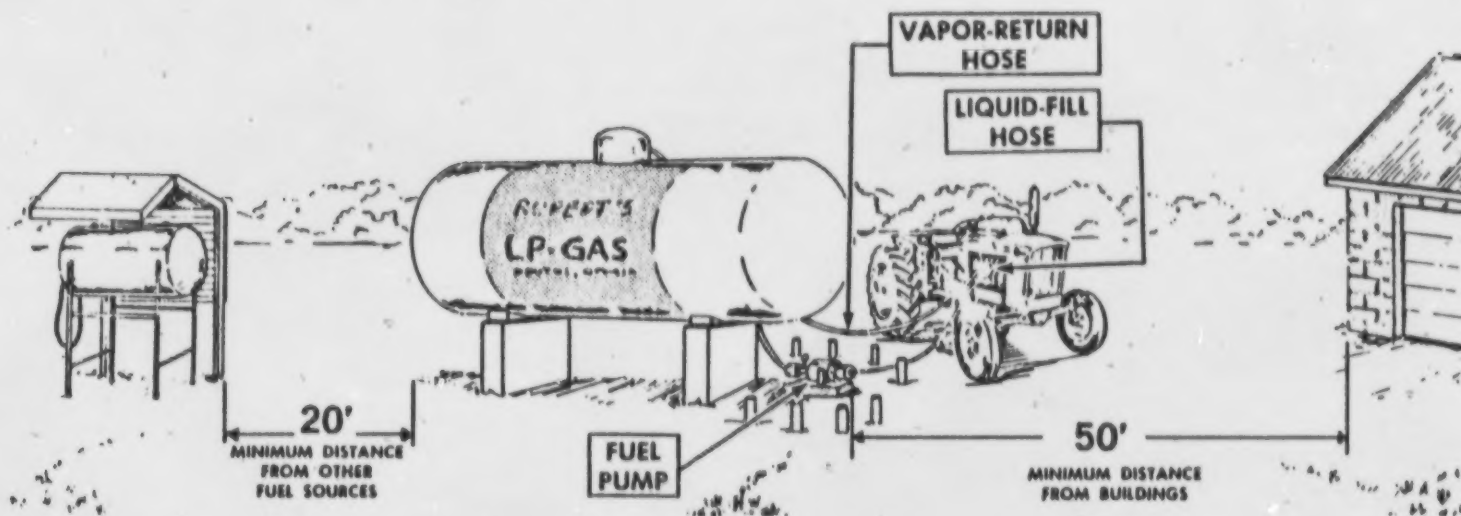
1. Advantages of underground tank
 - a. less fuel evaporation
 - b. less water condenses in the tank
 - c. less gum deposits form in the fuel
 - d. fire hazards are reduced
 - e. the tank is hidden, avoiding clutter around your building
2. Advantages of above ground tank
 - a. costs less to purchase
 - b. not affected by ground water and limited flooding
 - c. is easily moved

(NOTE: Above ground storage tanks are considered best for farm use because it is easy to find leaks by use of soap suds solution, in case any develop.)

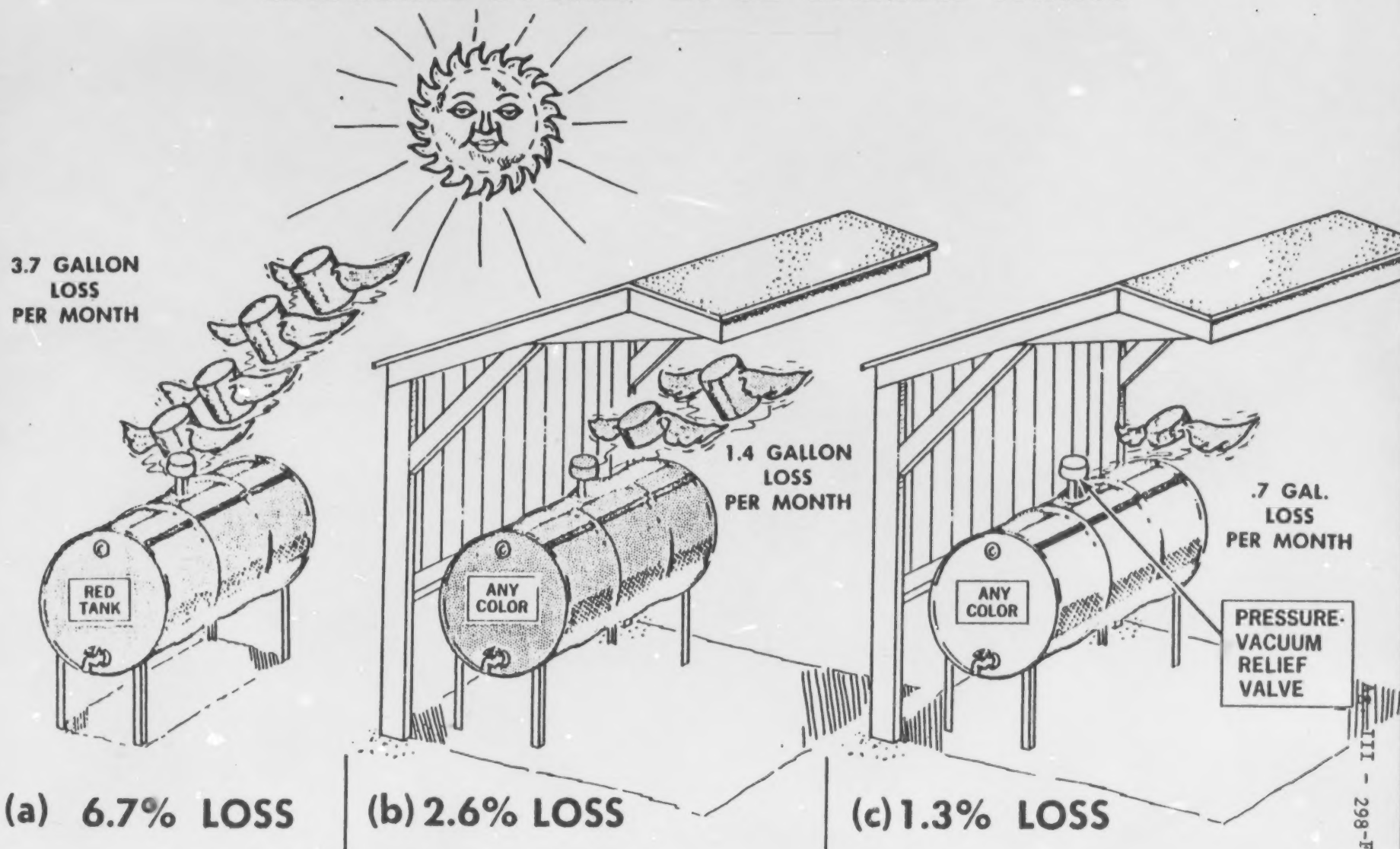
ABOVEGROUND STORAGE FOR FUEL



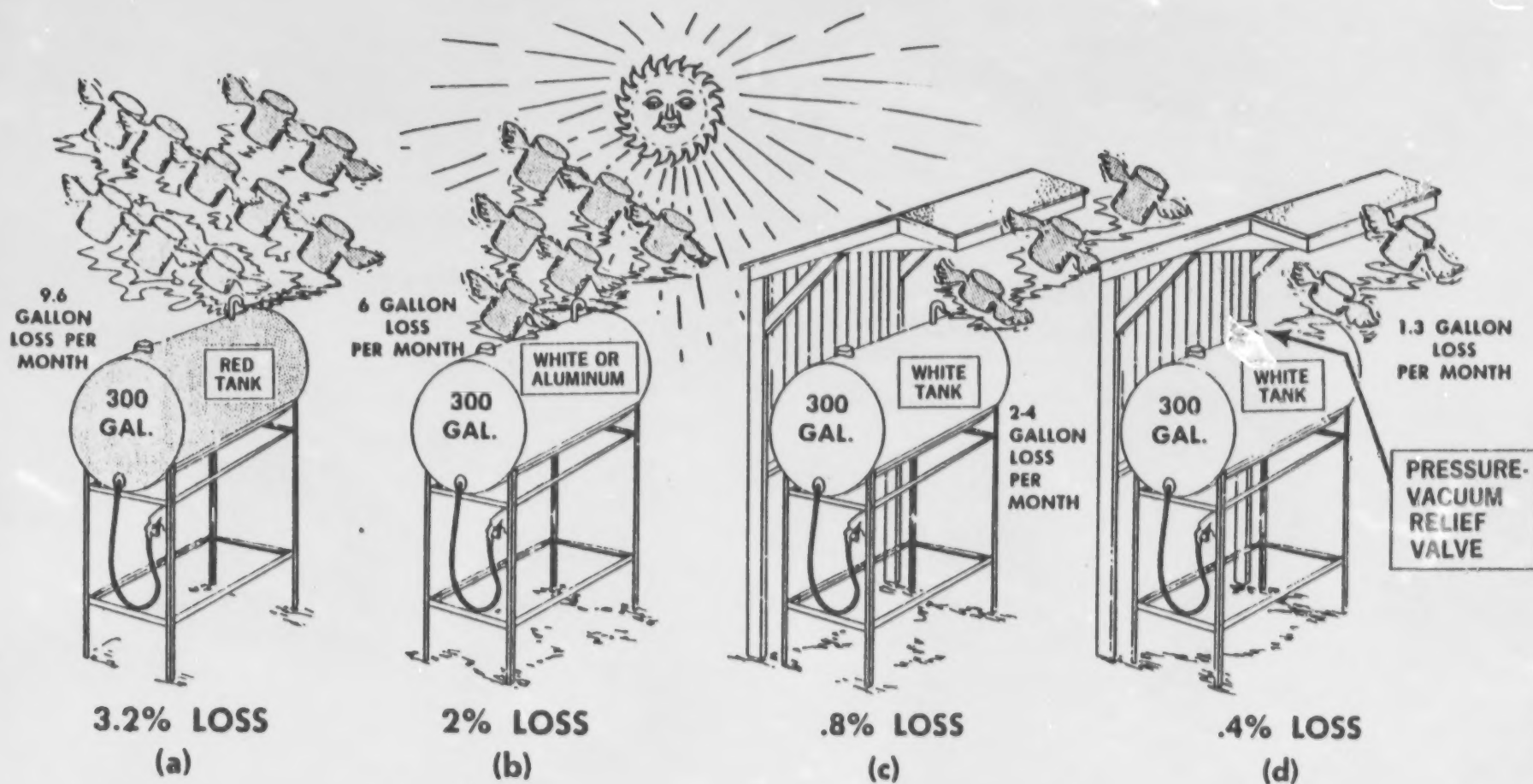
PROPER INSTALLATION OF AN LP-GAS STORAGE TANK



COMPARISON OF EVAPORATION RATES OF GASOLINE STORED IN 55 GALLON TANKS

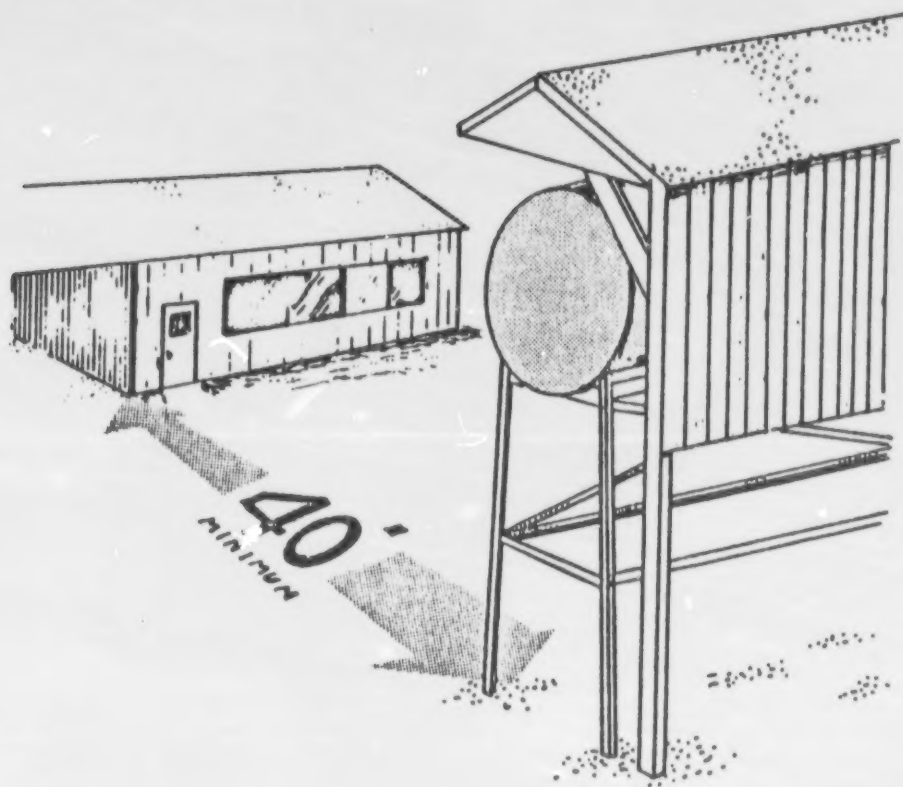


COMPARISON OF EVAPORATION RATES OF GASOLINE STORED IN 300 GALLON TANKS

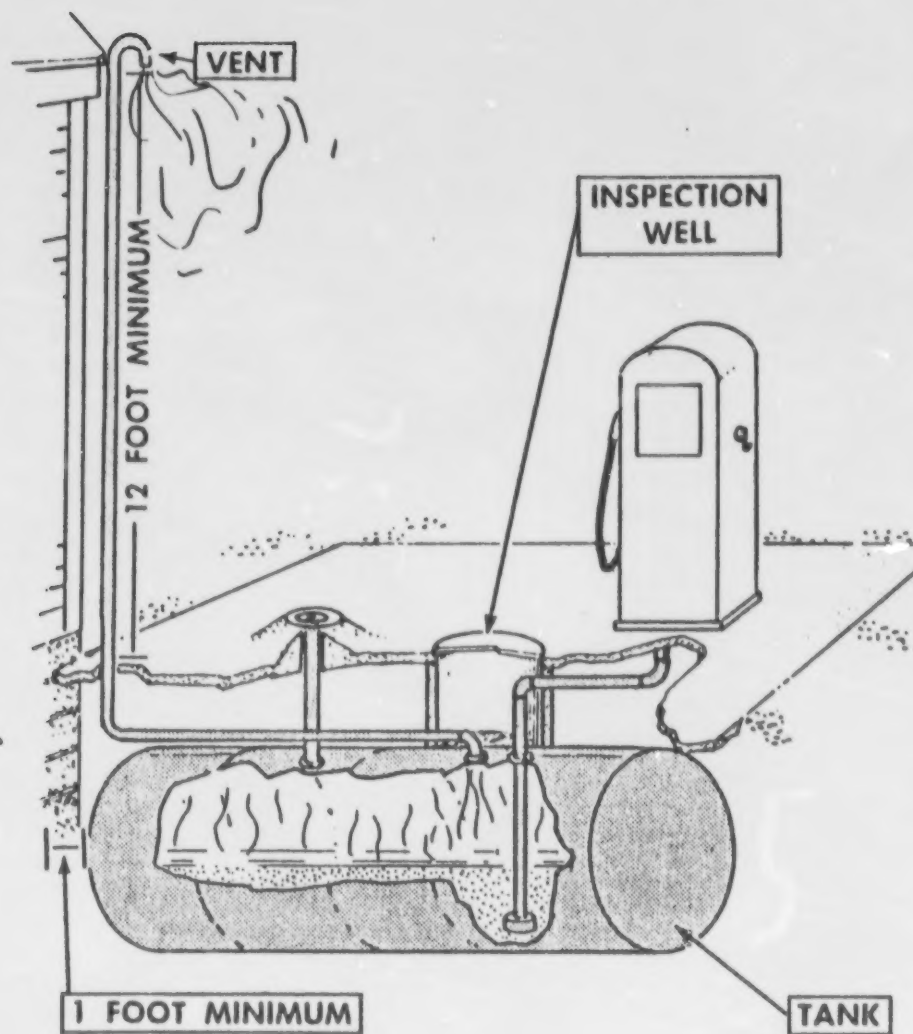


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PROPER INSTALLATION OF AN ABOVEGROUND STORAGE TANK



PROPER INSTALLATION OF AN UNDERGROUND STORAGE TANK



550

551

FARM FUELS
UNIT XII

ASSIGNMENT SHEET #1 - IDENTIFYING FARM FUELS

From the samples displayed, identify each as diesel fuel, gasoline or LP gas and list the characteristics:

Sample 1 _____

- Characteristics:
- a. liquid
 - b. reddish color
 - c. mild odor
 - d. highly explosive

Sample 2 _____

- Characteristics:
- a. liquid
 - b. dark yellowish color
 - c. strong odor
 - d. explosive

Sample 3 _____

- Characteristics:
- a. gas under pressure
 - b. no color
 - c. very highly explosive

FARM FUELS
UNIT XII

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

Sample 1 _____

Sample 2 _____

Sample 3 _____

Diesel fuel, LP gas, and gasoline.

Answered to satisfaction of
instructor.

FARM FUELS
UNIT XII

TEST

1. Match the terms on the right to the correct definition

- | | |
|---|------------------|
| _____ a. Method of comparing the antiknock qualities of fuels used in spark ignition engines. | 1. Volatitility |
| _____ b. A fuel's ability to vaporize easily. | 2. Octane rating |
| _____ c. Compounds added to fuels to increase its performance. | 3. Additive |
| _____ d. Liquefied petroleum gas | 4. LP gas |
| _____ e. Method of comparing the antiknock qualities of diesel fuel. | 5. Cetane number |

2. Using the examples on display, identify three types of farm fuels:

- a. _____
- b. _____
- c. _____

3. List five important qualities of farm fuels.

- a.
- b.
- c.
- d.
- e.

4. Discuss in a short paragraph the four factors to consider when storing farm fuels.

FARM FUELS
UNIT XII

ANSWERS TO TEST

1. a. 2
b. 1
c. 3
d. 4
e. 5

2. ____ a.
____ b.
____ c.

Answered to satisfaction of instructor. (Either LP gas, diesel fuel or gasoline according to instructor's arrangement.)

3. a. Proper octane or cetane rating.
b. Easy starting
c. High oxidation stability and freedom from gum deposit
d. Freedom from foreign material
e. Use of fuel additives
4. Answer should be centered around:
a. Protection of fuel quality
b. Safety
c. Convenience
d. Cost

ELECTRIC MOTORS UNIT V

TERMINAL OBJECTIVE

After completion of Unit V, the student should be able to identify the parts of an electric motor and select electric motors according to their starting circuits and capabilities. He should be able to identify types of bearings and motor enclosures and be able to disassemble an electric motor, clean the motor, and reassemble it. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able to:

1. Define five terms associated with electric motors.
2. Identify four types of A.C. single-phase, induction-run motors.
3. Discuss in a short paragraph the purpose of the built-in capacitor in a capacitor-start motor.
4. Identify the parts of an induction-run motor.
5. Name three electric motor requirements.
6. Name three factors to consider in selecting electric motors.
7. Discuss in a short paragraph the two thumb rules to follow in estimating the size of an electric motor that is to be purchased if the motor is 1/2 hp or less.
8. Select electric motors according to their starting circuits and capabilities.
9. Select factors to consider when replacing an electric motor.
10. Identify the two types of bearings used in electric motors.
11. Identify three types of motor enclosures and list where each is used.
12. Name four reasons for using motor mounts.
13. Name two reasons for having protective devices on motors.
14. Name six causes of excessive current in electric motors.
15. Name four types of protective devices for electric motors.
16. Name five common motor enemies.
17. Name six types of sensing devices used to control electric motors.
18. Demonstrate the ability to read, collect, and interpret name plate information found on electric motors.
19. Demonstrate the ability to disassemble, clean, and reassemble an electric motor.

ELECTRIC MOTORS
UNIT V

INFORMATION SHEET

I. Terms and definitions

- A. Single-phase--A type of electric service available to most farms requiring one transformer between power supplier and customer
- B. Split-phase motor--The cheapest electric motor available; used for easy starting loads
- C. Induction-run motor--A motor that runs by induced current and does not have windings in the rotor
- D. Repulsion-start motor--A motor that has windings in the rotor and also has brushes and a commutator
- E. Capacitor-start motor--A motor that has a capacitor in the starting windings
- F. Horsepower (hp)--A unit of mechanical power which is equal to 746 watts of electrical power
- G. Short circuit--An improper connection between "hot" and "neutral" wires or between "hot" wires
- H. Three-phase motor--The most rugged, reliable, and satisfactory type of motor available; used for fairly difficult starting loads
- I. Service factor--A multiplier indicating the amount of overload permitted for the motor
- J. RPM--The number of revolutions a motor will turn per minute
- K. Automatic Motor control--A switch, relay, and/or a contactor capable of responding to a device that senses variations in temperature, humidity, light, and pressure
- L. Relay--A device capable of utilizing a sensing signal to open and close a (switch) circuit
- M. Power factor--That factor by which the volt-ampere product must be multiplied in order to obtain the actual power
- N. Commutator--A switch for reversing the direction of an electric motor.

II. Single-phase, induction-run motors (Transparency 1)

A. Split-phase

- 1. Cheapest electric motor available
- 2. Available in sizes up to 1/3 hp
- 3. Works on a single-phase power
- 4. Operates on 120 and/or 240 volt service
- 5. Used on easy starting loads (grinders, saws, washing machines)

ELECTRIC MOTORS UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information, assignment, and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheets.
- F. Demonstrate and discuss procedures for completion of assignment and job sheets.
- G. Give test.

II. Students:

- A. Read objectives.
- B. Study information sheets.
- C. Demonstrate the ability to accomplish the procedures outlined in assignment and job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
 1. TM 1--Types of Electric Motors
 2. TM 2--Parts of Induction-Run Motor
 3. TM 3--Types of Bearings
 4. TM 4--Types of Motor Enclosures
 5. TM 5--Motor Name Plate Information
- D. Assignment Sheet #1--Collect and Interpret Name Plate Information
- E. Job Sheet #1--Clean Electric Motors
- F. Test
- G. Answers to test

II. References

- A. Electric Motors For Kansas Farms. Cooperative Extension Service, Kansas State University, Manhattan, Kansas XE-E28

B. Repulsion-start

1. Uses single-phase power
2. Uses 120- and/or 240- volt service
3. Available in sizes from 1/6 to 10 hp
4. Used on hard-to-start loads

C. Capacitor-start, capacitor-run

1. Uses single-phase power
2. Has two capacitors
 - a. One for starting
 - b. One for running
3. Available in sizes of 5, 7 1/2, and 10 hp
4. Used on hard-to-start loads

D. Repulsion-start, capacitor-run

1. Uses single-phase power
2. A combination of the two motors listed above
(NOTE: The capacitor helps maintain running efficiency after the motor reaches operating speed.)
3. Available in sizes of 1 to 15 hp

III. Reasons for built-in capacitors - Gives additional starting torque without requiring additional amperage

IV. Parts of induction-run motor (Transparency 2)

- A. Ventilated end bell or shield
- B. Stator and frame
- C. Thermal protection
- D. Centrifugal starting switch
- E. Sleeve bearing
- F. Rotor and fans
- G. Resilient mounting
- H. Neoprene thrust washers

V. Motor requirements

- A. Must start the equipment load
- B. Must drive the load once it is started
- C. Must survive the abuse of the surroundings in which it operates

VI. Factors in selecting electric motors

- A. Type of electric power available
(NOTE: Single-phase or three-phase)
- B. Type and size of load
- C. Condition under which motor must operate

VII. Thumb rules to follow in estimating motor size

- A. If equipment can be continuously operated by hand, a 1/4 hp electric motor will do the job
- B. If a piece of equipment is driven satisfactorily by a gasoline engine, the engine can normally be replaced with an electric motor of about 2/3 to 3/4 as much horsepower as the engine.
- C. Example to replace a 2 hp gasoline engine

$2 \times 2/3 = 4/3$ - Select a 1 1/2 hp electric motor

VIII. Starting Circuits and Capabilities of Electric Motors

MOTORS	STARTING ABILITY	STARTING CURRENT	STARTING MECHANISM	SPEED	VOLTAGE	COST & SIZE	APPLICATION
Split-Phase	Easy-to-start loads	Draws 6 to 8 times its normal running current	Two windings	Constant	120 or 240	Cheapest; 1/20 to 3/4 hp	Light farm work used on such tools as pumps, grinders, and fans
Capacitor-Start, Induction-Run	Fairly difficult starting loads	Draws 3 to 6 times its full load	Two windings	Constant	120 or 240	25 to 40 percent more than the same size split-phase motor; 1/6 to 10 hp	Heavy duty farm use such as air compressors, power tools, and feed grinders
Capacitor-Start, Capacitor-Run	Hard starting loads	Draws 3 to 5 times its normal running current	Has a running capacitor and a special slow starting mechanism	Constant 900 to 3600 rpm	120/240 under 2 hp 240 over 2 hp	20 percent more than capacitor-start, induction-run 1/2 to 25 hp	General purpose farm use such as pumps, blowers, and conveyors
Repulsion-Start, Induction-Run	Very heavy starting loads	Draws 3 times the running current	No starting winding but has two running windings	Constant 1200 to 1800 rpm	120 and 240	Similar to capacitor motors; 1/6 to 20 hp	Large general purpose farm use such as feed mills, compressors, and silo unloaders
Universal	Easy starting		Brushes	Varies	120	Very economical 1/20 to 1 hp	Shop tools such as drills and saws
Shaded-Pole	Easy starting	Can be designated as having low, normal, or high;	Shaded windings, slow starting	Varies	120	Very economical 1/20 to 1/4 hp	Small household fans, blowers, and hair dryers
Three-Phase	Variety of starting loads; usually for heavy, hard starting	Can be designated as having low, normal, or high, 3 to 4 times, the running current	Self-starting	Constant 400 to 3600 rpm	Voltage varies; used on large voltage	Expensive; 1/2 to many hundred hp	Used on loads requiring 10 hp or greater

IX. Replacing electric motors

- A. Horsepower rating must be the same or not more than one size larger
- B. Full-load speed, cycles, duty, and base must be the same
- C. Voltage 120 and/or 240

(NOTE: Type should be the same as the motor being replaced or a type having equal or greater starting torque.)

- D. Type should be the same

(NOTE: Type should be the same as the motor being replaced or a type having equal or greater starting torque.)

X. Types of bearings (Transparency 3)

A. Sleeve

- 1. Oil lubricated
- 2. Shaft must be mounted parallel to the floor

B. Ball

- 1. No problems of oil loss
- 2. Installed in any position

XI. Types of motor enclosures (Transparency 4)

- A. Open drip-proof - Used on most farms where water is not being sprayed
- B. Splash-proof - Designed for either indoor or outdoor use such as milk barns or irrigation pumps
- C. Totally enclosed - Used where dust and grit are a problem
- D. Totally enclosed explosion-proof - Used around explosive materials such as oil and gasoline

XII. Reasons for using motor mounts

- A. Anchors motor in position
- B. Provides for motor adjustment
- C. Reduces vibration
- D. Provides means of making motor portable

XIII. Reasons for having protective devices

- A. Protects excessive overcurrent
- B. Prevents short circuits

XIV. Causes of excessive current

- A. Load too heavy
- B. Machine locked or jammed
- C. Belt too tight
- D. Bearings worn or needing lubrication
- E. Voltage lower than name plate indication
- F. Motor and equipment pulley out of line

XV. Protection for electric motors

- A. Built-in overload protection in motor
- B. Manual starting switch with overload protection
- C. Magnetic starting switch with overload protection
- D. Time-delay fuse in motor for disconnect switch

XVI. Common motor enemies

- A. Dust
- B. Stray oil
- C. Moisture
- D. Bearing friction
- E. Pulley misalignment
- F. Vibration
- G. Uneven wear
- H. Overload
- I. Inadequate wiring

XVII. Sensing devices

- A. Temperature
- B. Humidity and moisture
- C. Light
- D. Pressure
- E. Timing
- F. Reversing
- G. Solenoid

XVIII. Name plate information (Transparency 5)

- A. Type of current - Alternating or direct; single-phase or three-phase
- B. Type of overload protection

(NOTE: The term thermalguard is a manufacturer's identification for a specific overload protection device built into the motor)

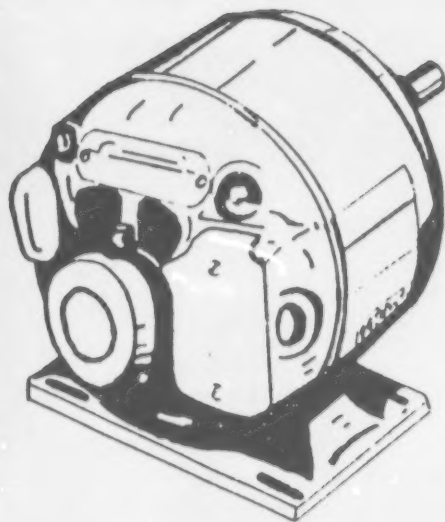
- C. Horsepower
- D. RPM - Indicates the speed of the motor shaft
- E. Temperature at which motor is to operate
- F. Hours that motor can be operated continuously
- G. Volts
- H. Type of enclosure
- I. Motor type

(NOTE: The various manufacturers usually use different letters and symbols to identify the various types of motors as to their starting mechanism. Very often the symbols sp-split-phase, start; cs-capacitor-start; and rs-repulsion-start are used.)

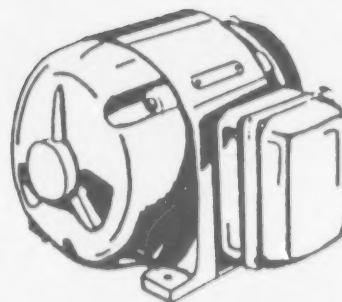
- J. Type of frame
- K. Cycle
- L. Serial number

(NOTE: This number should be used when writing to the manufacturer regarding the specific motor.)

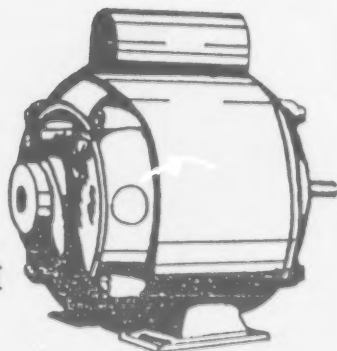
Types of Electric Motors



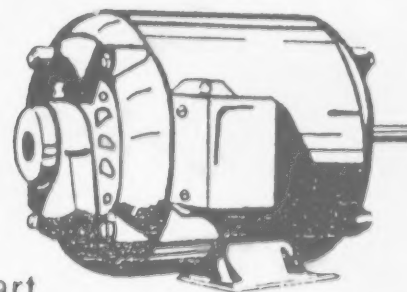
Split-Phase



Capacitor-Start, Capacitor-Run

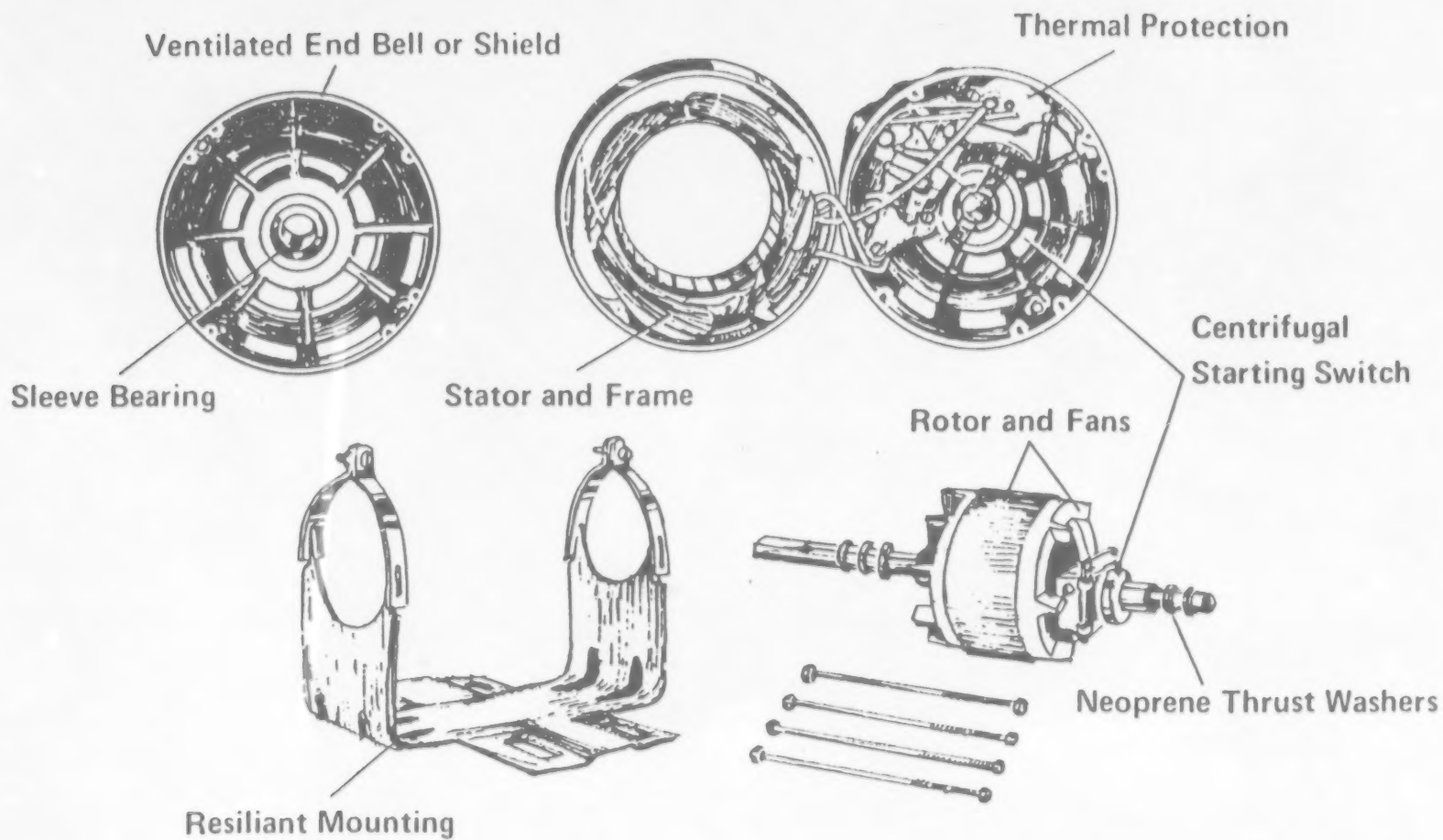


Capacitor-Start



Repulsion-Start

Parts of an Induction-Run Motor



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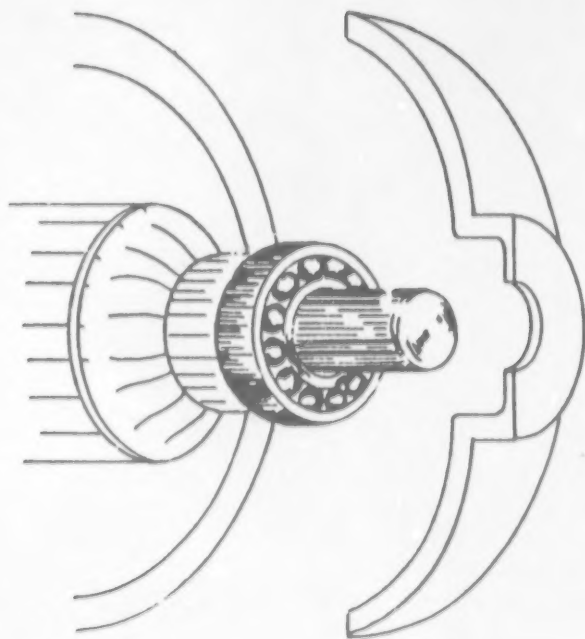
TM 2

Courtesy M. J. Morford

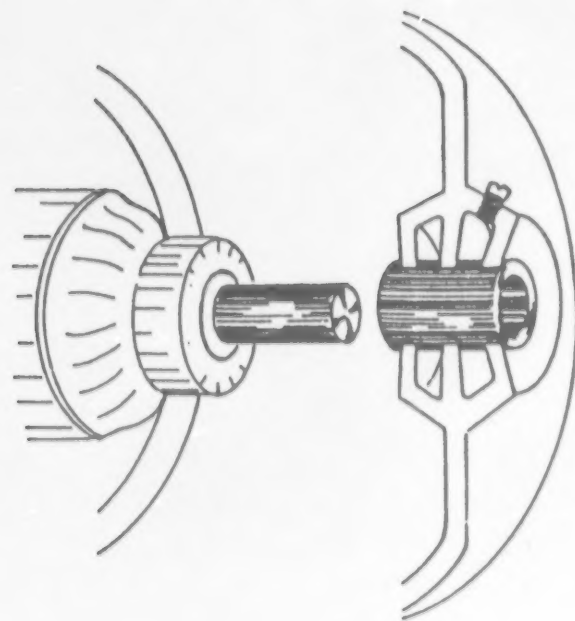
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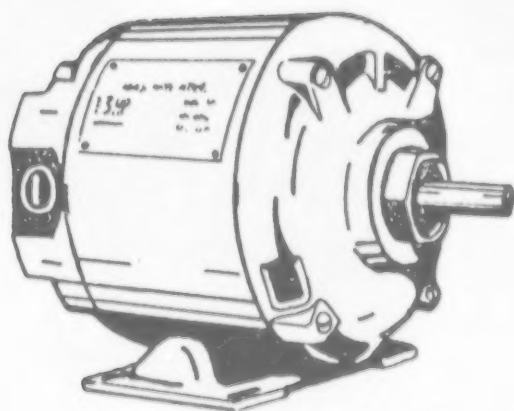
Types of Bearings



Ball

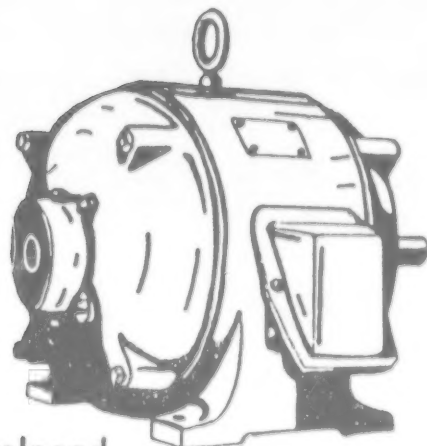


Sleeve

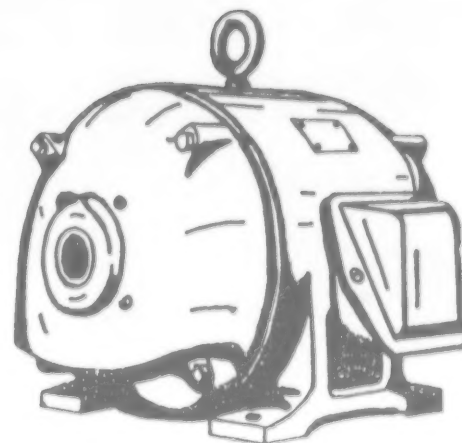


Open Drip-Proof

Types of Motor Enclosures

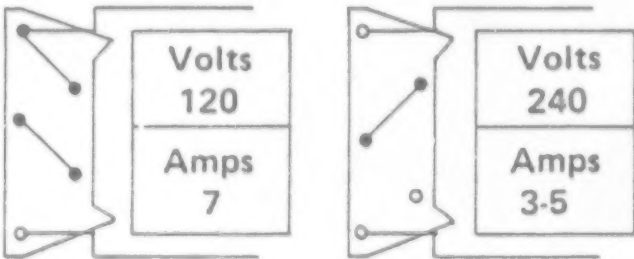


Totally Enclosed



Splash-Proof

Motor Name Plate Information

A.C. IPH		Motor Type F J	
Thermoguard Type			A
HP 1/2		Frame 186	
R. P. 1725 M.		C Y 60 C	
C 40	Hours Cont	Locked KV-A	
Serial 1180016-B			Style GO
			
OPEN			
30248 MADE IN USA			

ELECTRIC MOTORS
UNIT VASSIGNMENT SHEET #1 - COLLECT AND INTERPRET NAME PLATE
INFORMATION

Select an electric motor that is in your school shop or at your home and complete the following questions. Return to instructor when finished for his evaluation.

1. What is the horsepower of the motor? _____
2. What does the horsepower fraction tell you? _____
3. What is the rpm of the motor? _____
4. What does rpm tell you about this particular motor? _____
5. What is the recommended voltage to which this motor should be connected? _____
6. What type of overload protection does the motor have? _____
7. How long is the motor designed to operate? _____
8. Under what temperature will the motor operate? _____
9. What type of enclosure does the motor have? _____
10. With this type of enclosure, where would you recommend using it?

11. What is the serial number? _____
12. When would you use the serial number of a motor? _____
13. At how many cycles does the motor operate per second? _____
14. What is the motor type? _____
15. What type of current does the motor use? _____

ELECTRIC MOTORS
UNIT V

JOB SHEET #1 - CLEAN ELECTRIC MOTORS

- I. Tools and equipment
 - A. Motor
 - B. Standard screwdriver
 - C. Open-end adjustable wrench
 - D. Tire pump or vacuum cleaner
 - E. Center punch
 - F. Hammer
 - G. Small socket wrench set
 - H. Soft-faced mallet

- II. Materials
 - A. Non-flammable cleaning fluid
 - B. Clean rags (lintless)

- III. Procedures
 - A. Disconnect motor and remove from mounting
 - B. Clean out surface of motor
 - C. Disconnect wires at motor
(NOTE: Be sure and pay close attention to wire positions on motor terminals.)
 - D. Remove motor pulley
 - E. Mark bell ends
(NOTE: This is to keep bell ends in their proper places. Using center punch, place one mark on pulley end bell and two marks on opposite end bell; mark housing same way.) (Figure A)
 - F. Remove bolts holding end bells (Figure B)
 - G. Use soft-faced mallet and screwdriver to tap end bells loose (Figure C)
 - H. Remove bell end that does not contain the starting switch or brush ring
(NOTE: Observe position and number of shims as you remove the rotor)
 - I. Remove bell end containing starting switch
(CAUTION: Do not attempt to remove stator.)

- J. Using very fine sandpaper, clean points
(CAUTION: Do not use emery cloth.)
- K. Clean all parts of motor using special cleaning fluid
(NOTE: Do not get liquid on wires.)
- L. Use tire pump or vacuum cleaner to dry parts
- M. Clean bearings and make sure wicking is in place
- N. Replace bell end containing switch
- O. Insert rotor making sure shims are in place
(NOTE: A drop of oil should be placed on bearing part of the shaft.)
- P. Check position of end bells with center punch marks
(NOTE: Oil well should be up and window in bearing not in line of pull.)
- Q. Use soft-faced hammer to tap bells in place (Figure D)
- R. Insert end bell bolts and tighten (Figure E.)
- S. Turn shaft by hand
(NOTE: If it is tight, end bells may not be in proper alignment, or the wicking may be between bearing and shaft.)
- T. Connect temporary leads and test motor

JOB SHEET #1

IV. Diagram of procedures

Figure A

Mark bell ends

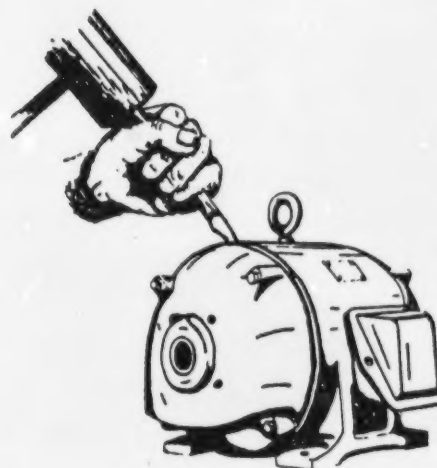


Figure B

Remove bolts

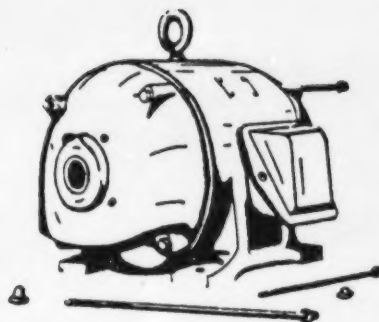
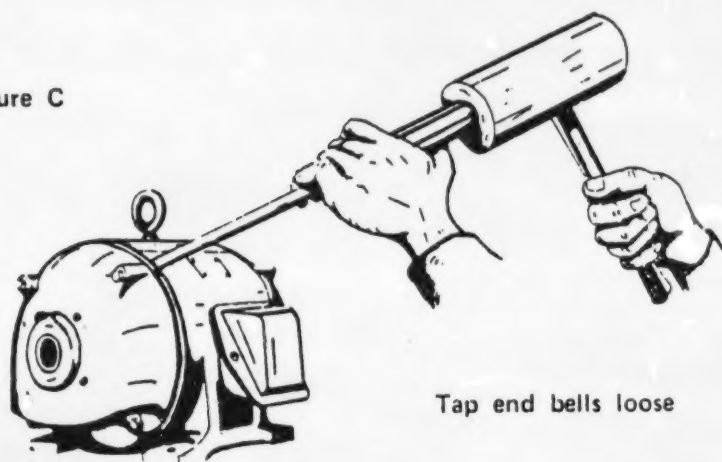


Figure C

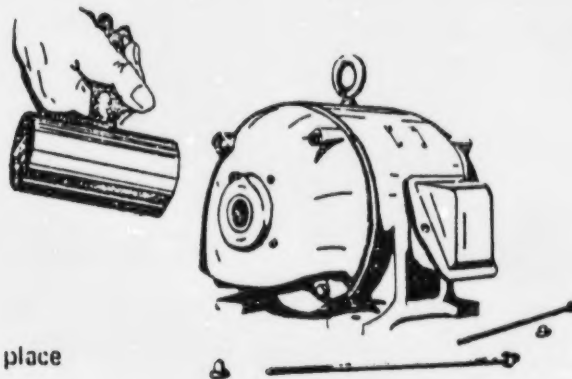
Tap end bells loose



JOB SHEET #1

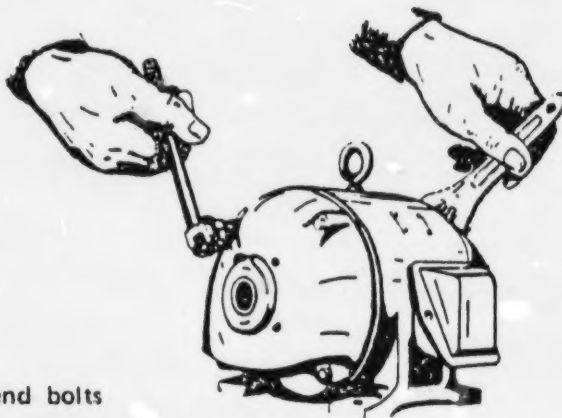
IV. Diagram of procedure

Figure D



Tap bells in place

Figure E



Insert end bolts

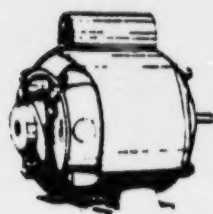
ELECTRIC MOTORS UNIT V

TEST

1. Define the following terms.

- a. Service factor
- b. Single-phase
- c. Induction-run motor
- d. RPM
- e. Relay

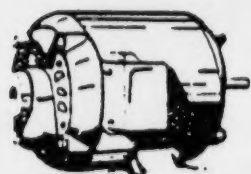
2. Identify the following types of electric motors.



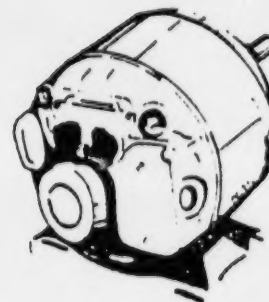
a. _____



b. _____



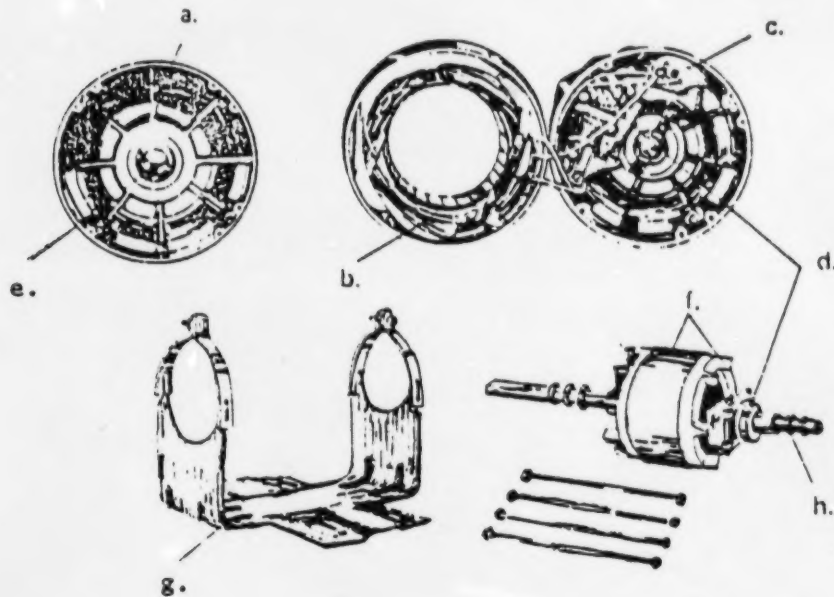
c. _____



d. _____

3. Discuss in a short paragraph the purpose of the built-in capacitor in a capacitor-start motor.

4. Identify the parts of the induction-run motor.



a. _____
 c. _____
 e. _____
 g. _____

b. _____
 d. _____
 f. _____
 h. _____

5. Name three electric motor requirements.

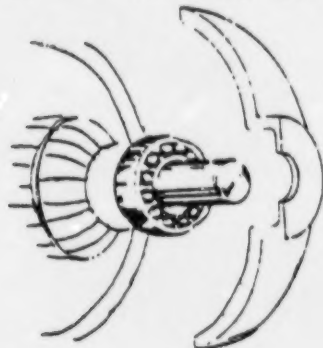
a.
 b.
 c.

6. Name three factors to consider in selecting electric motors.
- a.
 - b.
 - c.
7. Discuss in a short paragraph the two thumb rules to follow in estimating the size of an electric motor that is to be purchased if the motor is 1/2 hp or less.
8. Select the motor from the list below which describes the starting circuits and capabilities of each motor. (Place the correct number in the blank to the left of the definition.)
- | | |
|---|-----------------------------------|
| _____ a. An easy starting motor used on 120-volt service usually used in fans and blowers | 1. Split-phase |
| _____ b. A motor that is used to start easy loads, but will draw 6 to 8 times its normal running current while starting | 2. Shaded-pole |
| _____ c. A motor that is used on heavy starting loads while drawing only 3 times its running current; has notstarting windings but has 2 running windings | 3. Three-phase |
| _____ d. A motor that is used on fairly difficult starting loads, while drawing 3 to 6 times its full load on start; recommended for heavy duty farm use | 4. Repulsion start, induction-run |
| _____ e. A very expensive motor that has a variety of starting loads, also has a self starting mechanism and can be used on very high voltage | 5. Capacitor-start, capacitor-run |
| _____ f. A motor that is recommended for hard starting loads, normally draws 3 to 5 times it normal running current, and has a special slow starting mechanism along with a running capacitor | 6. Capacitor-start, induction-run |

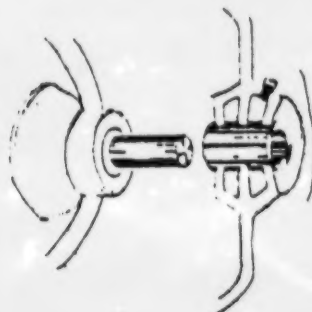
9. Place an "X" in the blank below if the statement would aid you in making a decision in regard to replacing an electric motor.

- a. Type does not have to be the same
- b. Voltage either 115 and/or 230
- c. Full load speed, cycles, duty, and base must be the same
- d. Horsepower rating does not apply

10. Identify the following types of electric motor bearings.

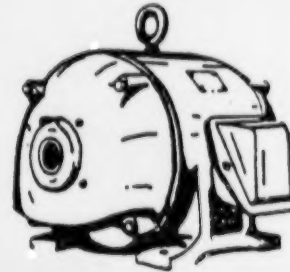
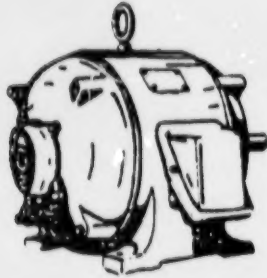


a. _____



b. _____

11. Identify the following types of motor enclosures and list where each is used.

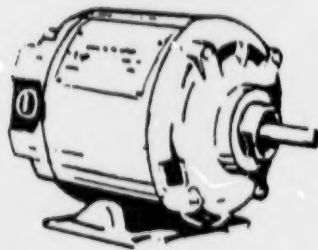


a. _____

b. _____

Where used _____

Where used _____



c. _____

Where used _____

12. Name four reasons for using motor mounts.

- a.
- b.
- c.
- d.

13. Name two reasons for having protective devices on motors.

- a.
- b.

14. Name six causes of excessive current in electric motors.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.
15. Name four types of protective devices for electric motors.
 - a.
 - b.
 - c.
 - d.
16. Name five common motor enemies.
 - a.
 - b.
 - c.
 - d.
 - e.
17. Name six types of sensing devices used to control electric motors.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.
18. Performance skills will be given on the following:
 - a. Demonstrate the ability to collect and interpret name plate information found on electric motors.
 - b. Demonstrate the ability to disassemble, clean, and reassemble an electric motor.

ELECTRIC MOTORS
UNIT V

ANSWERS TO TEST

1.
 - a. A multiplier indicating the amount of overload permitted for the motor
 - b. A type of electric service available to most farms, requiring one transformer between power supplier and customer.
 - c. A motor that runs by induced current and does not have windings in the rotor
 - d. The number of revolutions a motor will turn per minute
 - e. A device capable of utilizing a sensing signal to open and close a (switch) circuit
2.
 - a. Capacitor-start, induction-run
 - b. Capacitor-start, capacitor-run
 - c. Repulsion-start
 - d. Split-phase
3. The discussion should be centered around the following statement:
Gives additional starting torque without requiring additional amperage
4.
 - a. Ventilated end bell or shield
 - b. Stator and frame
 - c. Thermal protection
 - d. Centrifugal starting switch
 - e. Sleeve bearing
 - f. Rotor and fans
 - g. Resilient mounting
 - h. Neoprene thrust washers
5.
 - a. must start the equipment load
 - b. Must drive the load once it is started
 - c. Must survive the abuse of the surroundings in which it operates

6.
 - a. Type of electric power available
 - b. Type and size of load
 - c. Condition under which motor must operate
7. The discussion should mention that if equipment can be continuously operated by hand, a 1/4 hp electric motor will do the job; also if a piece of equipment is driven satisfactorily by a gasoline engine, the engine can normally be replaced with an electric motor of about 2/3 or 3/4 as much horsepower as the engine
8.
 - 2 a.
 - 1 b.
 - 4 c.
 - 6 d.
 - 3 e.
 - 5 f.
9.
 - b, c
10.
 - a. Ball
 - b. Sleeve
11.
 - a. Totally enclosed - Used where dust and grit are a problem
 - b. Splash-proof - Use - Designed for either indoor or outdoor use
 - c. Open drip-proof - Used on most farms where water is not being sprayed
12.
 - a. Anchors motor in position
 - b. Provides for motor adjustment
 - c. Reduces vibration
 - d. Provides means of making motor portable
13.
 - a. Protects excessive overcurrent
 - b. Prevents short circuits
14.
 - a. Load too heavy
 - b. Machine locked or jammed
 - c. Belt too tight

- d. Bearings worn or needing lubrication
 - e. Voltage lower than name plate indication
 - f. Motor and equipment pulley out of line
15. a. Built-in overload protection in motor
- b. Manual starting switch with overload protection
 - c. Magnetic starting switch with overload protection
 - d. Time-delay fuse in motor to disconnect switch
16. Any five of the following:
- a. Dust
 - b. Stray oil
 - c. Moisture
 - d. Bearing friction
 - e. Pulley misalignment
 - f. Vibration
 - g. Uneven wear
 - h. Overload
17. Any six of the following:
- a. Temperature
 - b. Humidity and moisture
 - c. Light
 - d. Pressure
 - e. Timing
 - f. Reversing
 - g. Solenoid
18. Performance skills will be evaluated by the instructor.

ELECTRICAL WIRING PRACTICES UNIT III

TERMINAL OBJECTIVE

After completion of Unit III, the student should be able to identify electrical tools, devices, and conductors. He should be able to recognize factors determining correct wire size to use and select wire size for safety, economy, and quality service, and demonstrate his ability to wire receptacles and lighting outlets. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the post test.

SPECIFIC OBJECTIVES

After completion of instruction, the student should be able to:

1. Define five terms associated with electrical wiring.
2. Identify ten tools used in electrical wiring when given the tools or a drawing illustrating the tools.
3. Identify the electrical devices when given the devices or a drawing.
4. Identify ten conductors as either wire, cord, or cables; tell type of insulation, wire size, AWG, or cir. mills; and give use of each.
5. Name three factors affecting voltage drop.
6. Name the three-step procedure to follow in wiring.
7. Draw a schematic diagram showing two lights connected in a series and controlled by a switch.
8. Distinguish between wiring diagrams and schematic diagrams.
9. Demonstrate the procedure for performing the following jobs:
 - a. Wire a lighting outlet controlled by a single-pole switch.
 - b. Wire two duplex receptacles using non-metallic cable.
 - c. Wire a lighting outlet controlled by two three-way switches.

ELECTRICAL WIRING PRACTICES
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives with students.
- E. Discuss information sheets with students.
- F. Demonstrate procedures for completing job sheets.
- G. Give test.

II. Students:

- A. Read objective sheet.
- B. Study information sheets.
- C. Demonstrate ability to complete procedures outlined in job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheets
- C. Transparency masters
 - 1. TM 1 - Electrical Wiring Tools
 - 2. TM 2 - Electrical Wiring Tools
 - 3. TM 3 - Electrical Devices
- D. Job sheets
 - 1. Job Sheet #1 - Wire a Lighting Outlet Controlled by a Single-Pole Switch
 - 2. Job Sheet #2 - Wire Three Duplex Receptacles Using Non-Metallic Cable
 - 3. Job Sheet #3 - Wire a Lighting Outlet Controlled by Two Three-Way Switches

- E. Test
- F. Answers to test

II. References:

- A. Brown, Robert H. Farm Electrification. New York: McGraw-Hill Book Company, Inc.
- B. Phipps, Lloyd J., H.F. McColly, L.L. Scranton, and G.C. Cook. Farm Mechanics Text and Handbook. Danville, Illinois: The Interstate Printers and Publishers, Inc.
- C. Farm Electricity, State of Tennessee, Department of Education, Division of Vocational Education.
- D. Basic Electricity and Practical Wiring Lessons, The Pennsylvania State University, College of Agriculture, Department of Agricultural Education, University Park, Pennsylvania.
- E. Basic Home Wiring, Menlo Park, California: Lane Publishing Company.
- F. Basic Wiring, Alexandria, Virginia: Time-Life Books

ELECTRICAL WIRING PRACTICES
UNIT III

INFORMATION SHEET

I. Terms and definitions

- A. Conductors - The wires which carry the electricity or through which electricity flows
- B. Terminal - A device attached to the end of a wire or cable or to an electrical apparatus for convenience in making connections
- C. Schematic diagram - A step used in electrical wiring showing the connections that need to be made
- D. Wiring diagram - The plan which shows the electric circuit with items arranged and appearing so the job of connecting will be simplified
- E. Junction box - An outlet with a blank cover used to contain splices of a circuit
- F. Cable - Two or more wires put together inside an overall covering
- G. Cord - Several small wires wrapped in insulation, then covered with another layer of insulation
- H. Outlet box - A box-like device which is used to bring the wires to the location where a switch or outlet is installed
- I. Receptacle outlet - A device which contains the splices when a circuit is tapped for an appliance or a light
- J. Conduit - A thin-walled steel pipe used to protect electrical wires
- K. Single-pole toggle switch - A switch used to break the current in a single place
- L. 3-Way switch - A switch used to control lights and motors from two different places
- M. Common terminal - The dark colored terminal on a 3-way switch
- N. 4-way switch - A switch used to control lights and motors from three or more different places
- O. Wire gauge - A tool used to measure wire diameter
- P. Wire size - The measure of a wire diameter
- Q. Wire - A single conductor which carries electricity

II. Electrical wiring tools (Transparencies 1 and 2)

- A. Needle-nose pliers
- B. Lineman's pliers
- C. Diagonal pliers
- D. Wire strippers
- E. Screwdrivers
 - 1. Standard
 - 2. Phillips
- F. Pocket knife
- G. Hammer
- H. Wood chisel
- I. Electric drill
- J. Tape or rule
- K. Keyhole saw
- L. Hacksaw
- M. Test lamp
- N. Amp volt meter
- O. ~~Vise~~-grip pliers
- P. Fish tape and reel
- Q. Conduit bender

III. Electrical devices (Transparency 3)

- A. Single element fuse, 30-amp, Edison plug type
- B. Time delay fuse, 25-amp, Edison plug type
- C. Time delay fuse, 40-amp, cartridge type
- D. Polarized heavy duty plug cap, 230-V, 15 amp
- E. Fuse box cover/grounded outlet for fractional hp motor protection
- F. Single element fuse, 50-amp, cartridge type
- G. 1/2" connector for NM cable
- H. 15-amp duplex, 115/230-V, grounded receptacle, 3-wire
- I. 15-amp duplex, 115-V, grounded receptacle, 3-wire
- J. 50-amp, 115/230-V, cord receptacle cap
- K. 50-amp, surface receptacle, 3-wire, 115/230-V
- L. 3-wire receptacle, 30 amp, 115/230-V, twist lock
- M. Single-pole, single-throw 10-amp, toggle wall switch
- N. Single-pole, double-throw, or 3-way, 10-amp, toggle wall switch
- O. Crow foot polarized cord cap, 20-amp, 3-wire, 230-V.
- P. Polarized twist lock plug cap, 20-amp, 115/230-V., 3-wire

- Q. Handy box 1/2" knock-out and cover for toggle switch
- R. Handy box 1/2" knock-out and cover for duplex receptacle
- S. Wall box with clamps and beveled corners for switch or receptacle
- T. 4" x 1 1/2 octagon box, 1/2" knock-outs for ceiling outlets or junction box

IV. Conductors

<u>NO. ITEM</u>	<u>TYPE</u>	<u>AM.WIRE GUAGE</u>	<u>USE</u>	<u>REFERENCE</u>
A. Wire	A(392 1/4)	16STD	Heating Appliances Within Apparatus-Dry Locations	P.94 NEC
B. Wire	TW(140 1/4)	14	Inside of Conduit Dry and Wet Locations	P.93 NEC
C. Wire	USE	10	Trench-Lay - Under Ground	P.127 NEC
D. Wire	TW(Low Voltage)	18	Low Voltage Alarm Or Relay Controls	
E. Cord	HPN	16/2	Heater Cord	P.176 NEC
F. Cord	S	12/3	Hard Usage-Welders Large Motors	P/75 NEC
G. Cord	HC	16/2	Iron, Heaters	P.175 NEC
H. Cord	SJ	18/2	Portable Tools	P/74 NEC
I. Cord	SV	18/2	Vacuum Cleaners-Mixers	P.174 NEC
J. Cable	Triplex	6/3	Outside-Overhead Service	
K. Cable	UF	10/2	Underground-Feeder And Branch Circuits	P.128 NEC
L. Cable	NM	14/2G	Inside-Dry Locations	P.126 NEC

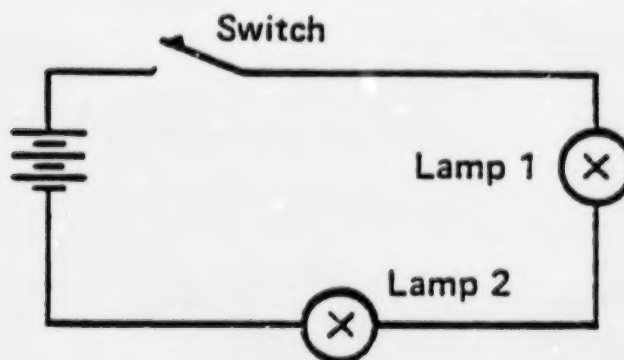
V. Factors affecting voltage drop

- A. Length of wire
- B. Size of wire
- C. Number of amps flowing through wire
- D. Type of conductor

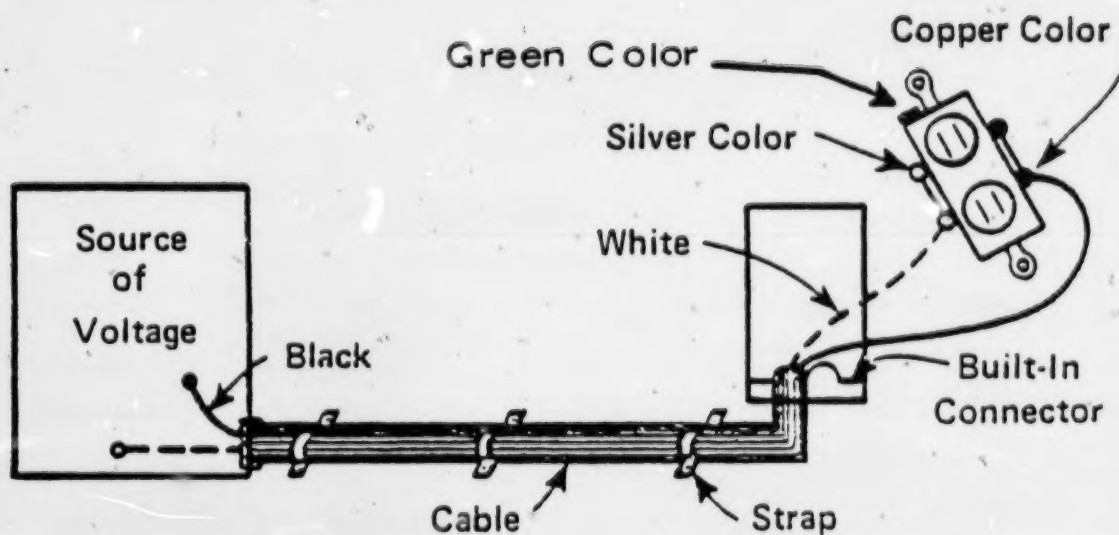
VI. Procedures to follow in wiring

- A. Draw the schematic diagram
- B. Draw the wiring diagram
- C. Install wire according to wiring diagram

VII. Schematic diagram



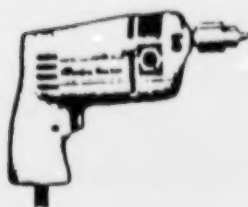
VIII. Wiring diagram



Electrical Wiring Tools



Hammer



Electric Drill



Hacksaw



Keyhole Saw



Needle Nose Pliers



Lineman's Pliers



Vise-Grip Pliers



Wire Cutter,
Stripper



Diagonal Pliers

593

594

Electrical Wiring Tools



Screwdriver



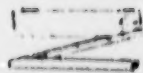
Chisel



Test Light



Conduit Bender



6-foot Folding Rule



Amp Volt Meter



Jackknife



Fish Tape and Reel

ELECTRICAL DEVICES



50 Amp 115/230 v. Cord
Receptacle Cap



Octagon Box



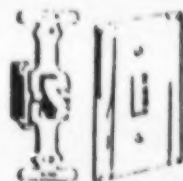
Beveled Corners
Wall Box



Connector



Time Delay Fuse
40 Amp Cartridge Type



Toggle Wall Switch
and Cover



Duplex Receptacle
and Cover



Single Element Fuse
30 Amp
Edison Plug Type

ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #1 - Wire a Lighting Outlet Controlled by a Single-Pole
Switch

I. Tools and equipment

- A. Standard screwdriver
- B. Lineman's pliers
- C. Needle-nose pliers
- D. Knife or strippers

II. Materials

- A. Lighting outlet
- B. Octagon box
- C. Single-pole toggle switch
- D. Handy box for single-pole switch
- E. 2 pieces of No. 12/2 NM wire, 2 feet long
- F. 1 piece of 2' x 3' x 1/2" plywood

III. Procedures

- A. Attach box for single pole switch to demonstration board (Figure A)
- B. Remove knock-out plugs and loosen screw in box and place one piece of NM wire under plate and allow approximately six inches extending from box (Figure B)
- C. Remove six inches of outside insulation on wire (Figure C)
- D. Tighten screw in box
(NOTE: NM wire cable should be secured with 1/4" of the outer insulation protruding through the clamp.)
- E. Remove approximately 1" of insulation from each wire
(CAUTION: This should be done in such a manner to not scratch or mark the wire.)
- F. Secure octagon box to demonstration board and remove knock-out plugs which are located directly across from each other (Figure A)

- G. Using the remainder of wire extending from handy box, run to octagon box, and use the same procedures for fastening wire to octagon box as in fastening to handy box.
- H. Remove six inches of outside insulation from wire.
- I. Remove approximately 1" of insulation from each wire
- J. Using the extra piece of wire, remove six inches of outside insulation and 1 1/2" of insulation from each wire and place through octagon box and secure to box
(NOTE: The end of wire extending from octagon box will be connected to electrical source.)
- K. Connect single-pole toggle switch to wires extending from handy box
(NOTE: Wires should be placed around terminals on switch according to the way the screw tightens.) (Figure D)
- L. Connect black "hot wire" to brass side of lighting outlet
(NOTE: Procedures should be the same for connecting the terminals.) (Figure E)
- M. White wire from switch should be connected to black wire which is designated as the source wire
(NOTE: This connection should be made with a pigtail splice and by using an insulation cap.) (Figure F)
- N. White source wire should be connected to the silver terminal on lighting outlet (Figure E)
- O. Place wires in handy box and fasten toggle switch to box (Figure G)
- P. Turn switch off and on to see if wiring is correct
- Q. Connect wire extending from octagon box to the electrical source
(CAUTION: Be sure to have instructor's approval before performing this step.)

IV. Diagram of procedure

Figure A

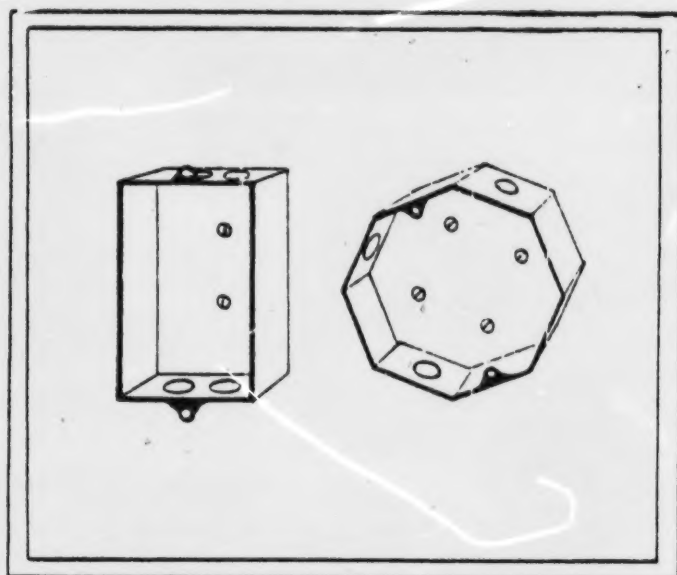


Figure C



Figure B



Figure D

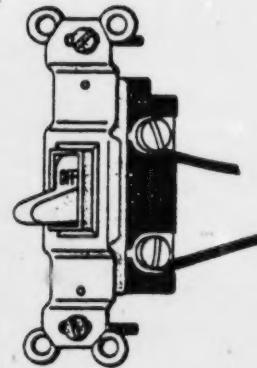


Figure E

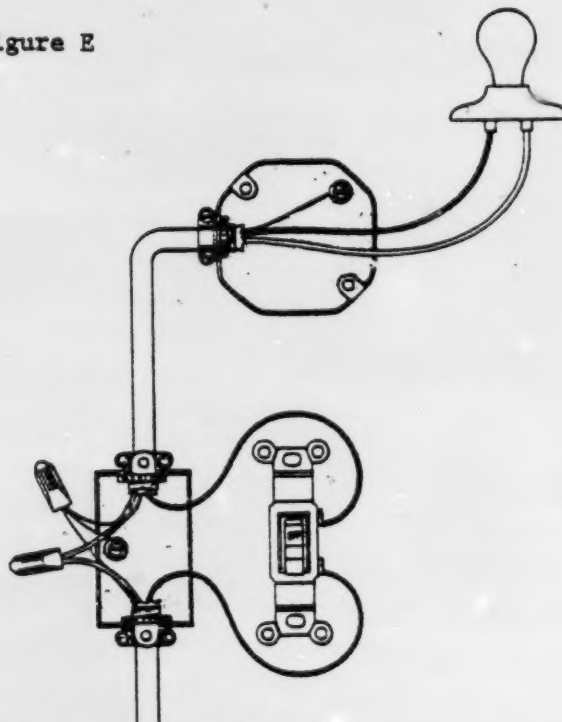
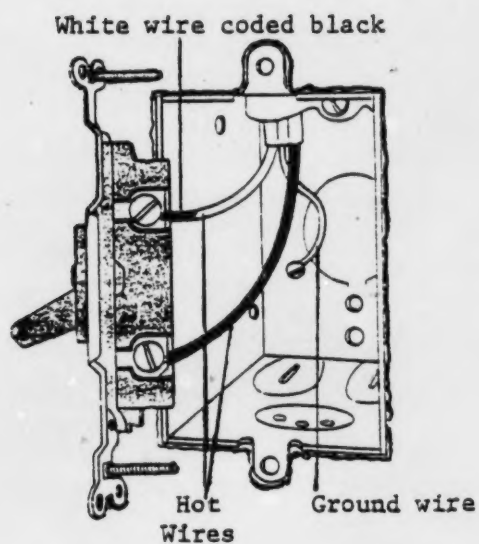


Figure F



Figure G



ELECTRICAL WIRING PRACTICES UNIT III

JOB SHEET #2 - Wire Two Duplex Receptacles Using Non-Metallic Cable

I. Tools and equipment

- A. Standard screwdriver
- B. Lineman's pliers
- C. Needle-nose pliers
- D. Knife or strippers

II. Materials

- A. Three duplex receptacles
 - B. Three flush wall boxes for receptacles
 - C. Three duplex receptacle cover plates
 - D. One piece of plywood 1/2" x 2' x 3'
 - E. Two pieces of No. 12/2 g NM wire 24 inches long
- (NOTE: Number wires 1 and 2)

III. Procedure

- A. Secure receptacle flush wall boxes to demonstration board (Figure A)
 - B. Remove knock-out plugs on box A on both ends, but remove only one knock-out on box B
 - C. Loosen screw inside both handy boxes (Figure B)
 - D. Remove six to eight inches of the outside covering on each end of the NM cables
 - E. Starting with box B, place wire one under screw plate and insert until outer cable covering extends 1/4 inch into the wall box and tighten screw
- (CAUTION: Tighten screw firmly but do not cut insulation.)(Figure C)
- F. Place remaining end of wire one under screw plate of box A and insert until outer cable covering extends 1/4 inch into the wall box and tighten screw.
 - G. Place wire two in box A under screw plate of box and insert until outer cable covering extends 1/4 inch into the wall box and tighten screw.
 - H. Remove approximately 1" of insulation from each wire extending from handy boxes

(NOTE: Remember to use caution in removing insulation from wires.)

- I. Starting with box B, attach black hot wire to brass side of receptacle

(NOTE: Wire should be placed around terminals according to the direction the screw tightens.) (Figure D)

- J. Attach white neutral wire to silver side of receptacle (Figure E)

- K. Attach green ground wire to the green hexagonal screw of receptacle (Figure E)

- L. Same procedures should be followed for attaching wires to receptacle A (Figure F)

- M. Assemble wires with receptacle and place in handy box; attach cover plate

- N. Check with instructor for approval before attaching wire two to electrical source

IV. Diagram of procedure

Figure A

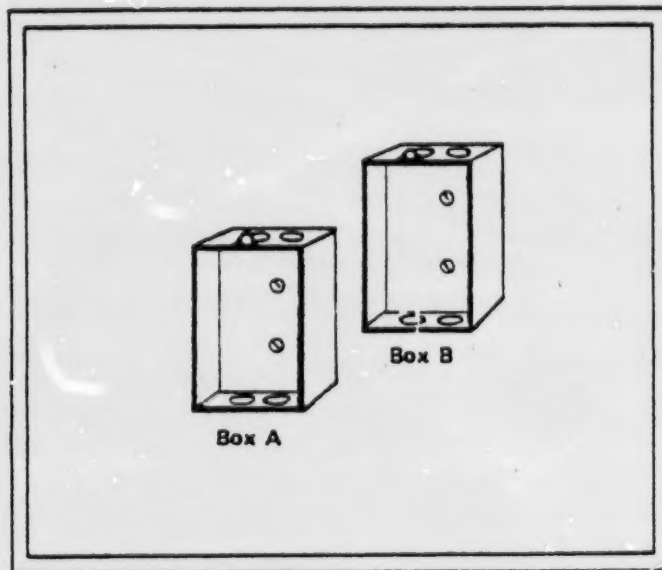


Figure B



Figure C



Figure D



Wrong



Right

Figure E

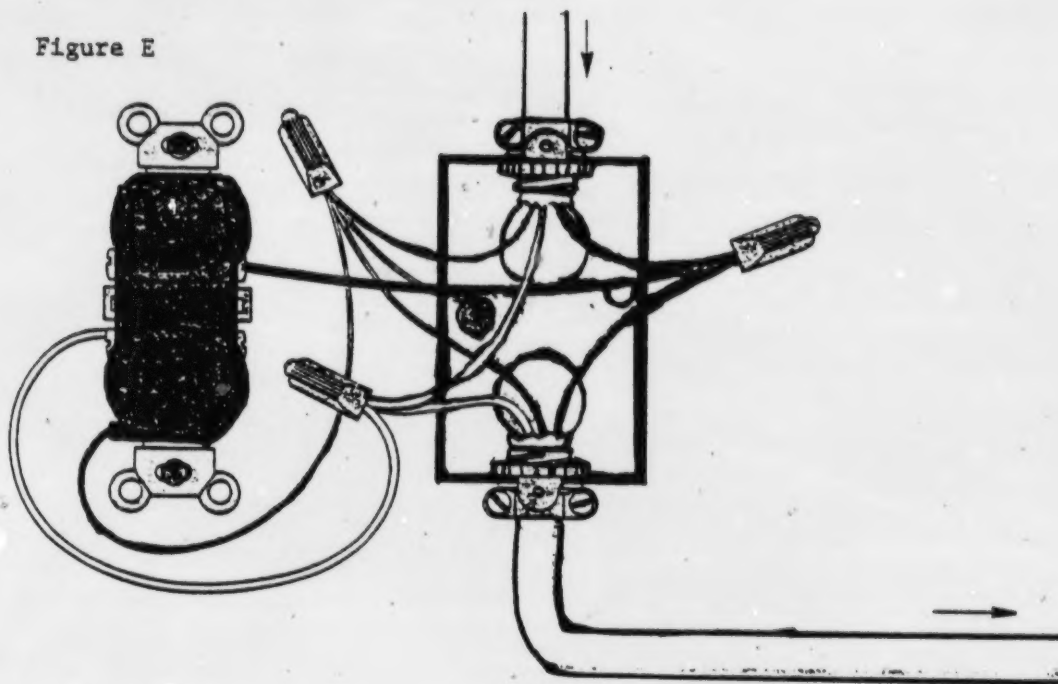
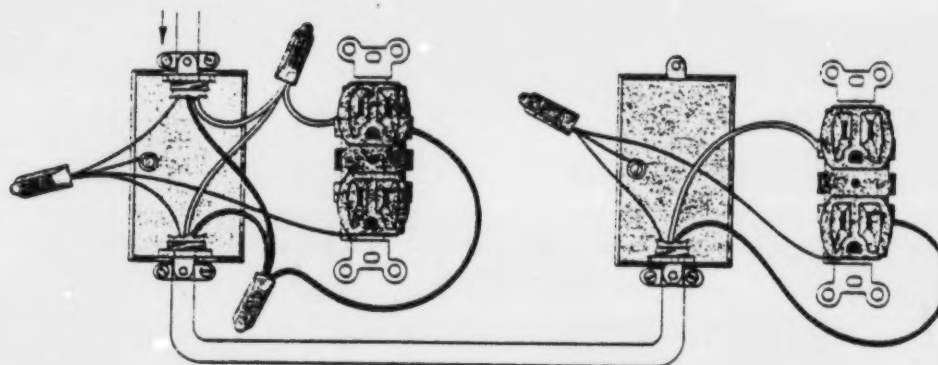


Figure F



ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #3 - Wire A Lighting Outlet Controlled By Two Three-Way
Switches

I. Tools and equipment

- A. Standard screwdriver
- B. Lineman's pliers
- C. Needle-nose pliers
- D. Knife or strippers

II. Materials

- A. Lighting outlet
- B. Octagon box
- C. Two three-way switches and cover plates
- D. Two flush mount wall boxes
- E. Black tape for tracer marking
- F. One piece of 12/3 NM cable, three feet long

(NOTE: In this job, the 12/3 NM cable contains 3 wires; the white wire will be used as the neutral; the black and red wires will alternate as the hot carrier from one switch to the other depending upon the switch position.)

- G. Two pieces of 12/2 NM cable, 2 feet long
- H. One piece of 2' x 3' x 1/2" plywood

III. Procedure

- A. Attach both wall boxes and the octagon box to plywood (Figure A)
- B. Remove six to eight inches of the outside covering on each end of the NM cables
- C. Remove bottom knock-out plug from wall box #1 and loosen screw in box; place one 12/2 NM cable under plate and insert until outer cable covering extends 1/4" into the wall box and tighten screw
- D. Remove 1 inch of insulation from wires (Figure B)

(CAUTION: Be careful not to nick wire when removing insulation.)

- E. Remove bottom knock-out plug from wall box #2 and loosen screw in box; place 12/3 NM cable under plate
(NOTE: While conducting this step, you will need to repeat steps C and D.)
- F. Remove top knock-out plug from wall box #1 and loosen screw in box; using the remainder of wire extending from wall box #2, run to wall box #1 and use the same procedure for fastening wire to wall box #1 as in fastening to wall box #2
(NOTE: While conducting this step, you will need to repeat steps C and D.)
- G. Remove top knock-out plug from wall box #2 and loosen screw in box; place one 12/2 NM cable under plate
(NOTE: While conducting this step, you will need to repeat steps C and D.)
- H. Remove knock-out plug on octagon box located directly across from wall box #2; using the remainder of wire extending from wall-box #2, run to octagon box and use the same procedure for fastening wire to octagon box as in fastening to wall box
(NOTE: While conducting this step, you will need to repeat steps C and D.)
- I. In wall box #1, connect black wire in 12/2 NM cable to three-way switch on screw C (common terminal); connect red wire in 12/3 NM cable to screw A and black wire in 12/3 NM cable to screw B (Figure C)
(NOTE: Wire should be placed around terminals on switch according to the way the screw turns)
- J. In wall box #2, connect black wire in 12/2 NM cable to three-way switch on screw C (common terminal); connect red wire in 12/3 NM cable to screw A and black wire in 12/3 NM cable to screw B (Figure C)
- K. Connect the two white wires in wall box #1 together using a pigtail splice and connecting cap
- L. Connect the two white wires in wall box #2 together using a pigtail splice and connecting cap
- M. Connect the two grounding wires and a six inch length of bare wire together in wall boxes #1 and #2 using a pigtail splice and connecting cap
- N. Connect free end of six inch bare wire to grounding screws in wall boxes #1 and #2
- O. Connect grounding wire to grounding screw in octagon box
- P. Connect the black wire in the octagon box to the brass screw on the light fixture
- Q. Connect the white wire in the octagon box to the silver screw on the light fixture
(CAUTION: Check with instructor before performing the next three steps.)

- R. Place wires in wall boxes and fasten switches to the boxes; install switch cover plates
- S. Place wires in octagon box and fasten light fixture to box
(CAUTION: Do not over tighten fixture.)
- T. Connect wire extending from wall box #1 to source
- U. Turn switches off and on to see if job is correct

IV. Diagram of procedure

Figure A

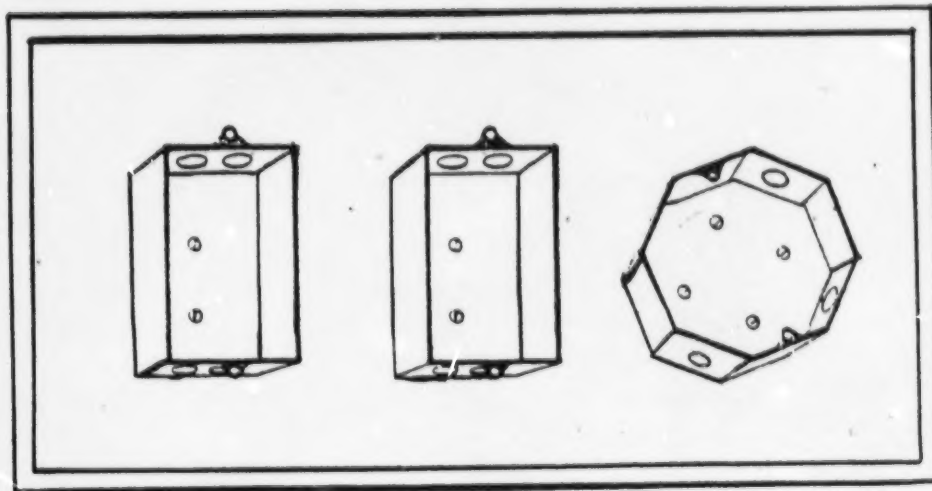


Figure B

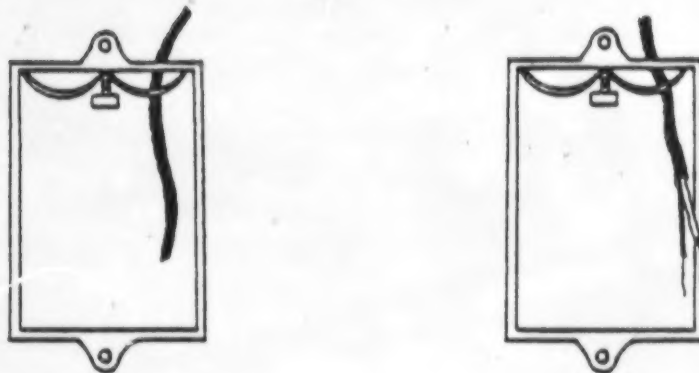
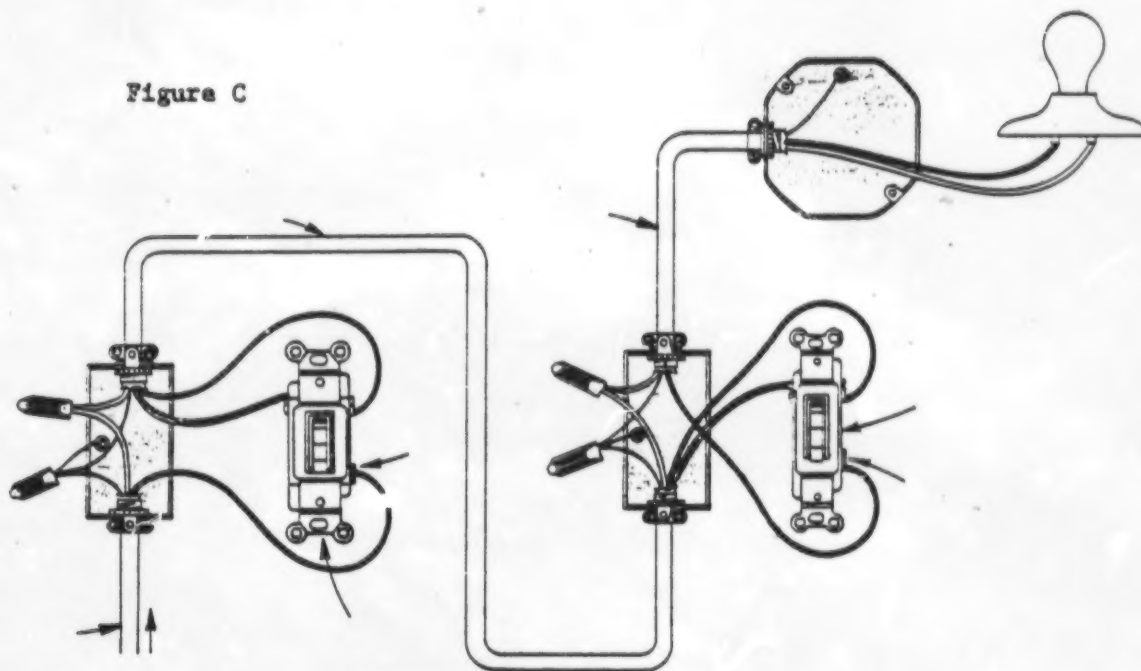


Figure C



ELECTRICAL WIRING PRACTICES
UNIT III

TEST

1. Define the following terms

- a. Cable -
- b. Junction box -
- c. Single-pole toggle switch -
- d. Wire gauge -
- e. Wire size -

2. Identify the following tools used in electrical wiring.



a. _____



b. _____



c. _____



d. _____



e. _____



f. _____



g. _____



h. _____



i. _____



j. _____

3. Identify the following electrical devices.



a. _____



b. _____



c. _____



d. _____



e. _____



f. _____



g. _____



h. _____



i. _____



j. _____

4. Complete the following chart while identifying electrical conductors.

ITEM	TYPE	Size AWG	Use
a.			
b.			
c.			
d.			
e.			
f.			
g.			
h.			
i.			
j.			

5. Name three factors affecting voltage drop.

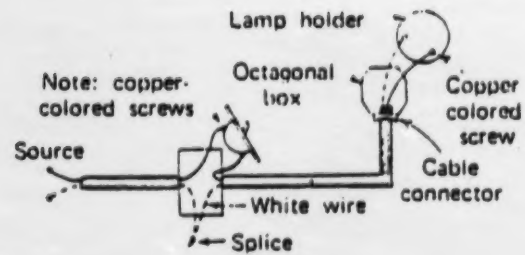
- a.
- b.
- c.

6. Name the three-step procedure to follow in wiring

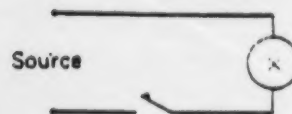
- a.
- b.
- c.

7. Draw a schematic diagram showing two lights connected in a series and controlled by a switch.

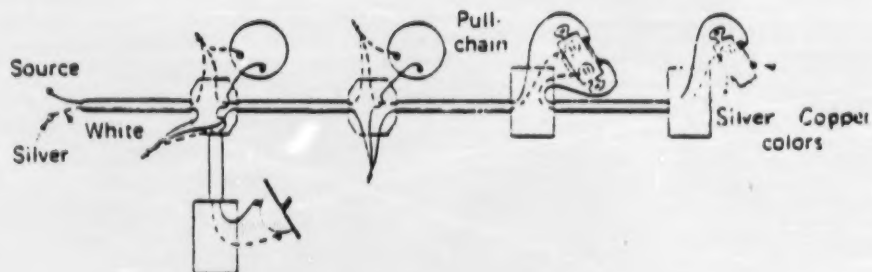
8. Identify the following drawings as either schematic or wiring diagrams.



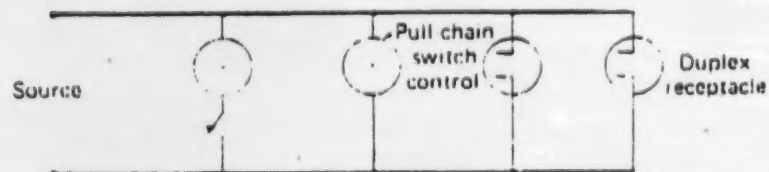
a. _____



b. _____



c. _____



d. _____

ELECTRICAL WIRING PRACTICES
UNIT III

ANSWERS TO TEST

1.
 - a. Two or more wires put together inside an overall covering
 - b. An outlet box with a blank cover used to contain splices of a circuit
 - c. A switch used to break the current in a single place
 - d. A tool used to measure wire diameter
 - e. The measure of wire diameter

2.
 - a. Lineman's pliers
 - b. Conduit bender
 - c. Wire cutter, strippers
 - d. Vise-grip pliers
 - e. Keyhole saw
 - f. Fish tape and reel
 - g. Hacksaw
 - h. Test light
 - i. Amp volt meter
 - j. Wood chisel

3.
 - a. Octagon box
 - b. Flush mount wall box
 - c. Single element fuse, Edison plug type
 - d. Fuse, cartridge type
 - e. Connector
 - f. Toggle wall switch
 - g. Cover for toggle wall switch
 - h. Cover for duplex receptacle
 - i. Grounded duplex receptacle
 - j. 50-amp, 115/230-V., cord receptacle cap

4.	ITEM	TYPE	Size AWG	Use
a.				
b.				
c.				
d.				
e.				
f.				
g.				
h.				
i.				
j.				

5. Any three of the following
 - a. Length of wire
 - b. Size of wire
 - c. Number of amps flowing through wire
 - d. Type of conductor
6.
 - a. Draw the schematic diagram
 - b. Draw the wiring diagram
 - c. Install wire according to wiring diagram
7. Evaluation will be made by the instructor.
8.
 - a. Wiring
 - b. Schematic
 - c. Wiring
 - d. Schematic

REPAIRING AND SHARPENING TOOLS
TWIST DRILL

TERMINAL OBJECTIVES

After completion of this unit, the student should be able to identify, select, and sharpen a twist drill. He should be able to select the proper cutting oil to use for different jobs. This will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define twist drill.
2. Identify the parts of a twist drill.
3. Match the degree of angle to the desired parts of the twist drill.
4. List four reasons for using cutting oil.
5. Name four classifications of cutting oils.
6. Match the common jobs to the correct cutting oils.
7. Name the four systems used for twist drill size designation.
8. Demonstrate the ability to sharpen a twist drill bit.

REPAIRING AND SHARPENING TOOLS
TWIST DRILL

SUGGESTED ACTIVITIES

- I. Instructor
 - A. Provide students with objectives
 - B. Provide students with information and job sheets
 - C. Make transparencies
 - D. Discuss terminal and specific objectives
 - E. Discuss information sheet
 - F. Demonstrate and discuss procedures outlined in job sheets
 - G. Give test
- II. Students
 - A. Read objectives
 - B. Study information sheet and take notes
 - C. Demonstrate the ability to accomplish the procedures outlined in the job sheets
 - D. Take test

INSTRUCTIONAL MATERIALS

- I. Included in this unit:
 - A. Objective sheets
 - B. Information sheet
 - C. Transparency masters
 - TM 1-The Twist Drill Bit
 - TM 2-Angles on the Twist Drill Bit
 - D. Job sheet
 - #1-Sharpening the Twist Drill
 - E. Test
 - F. Answers to test
- II. References

- A. Wakeman, T.J. and McCoy, V.E., The Farm Shop, The MacMillian Co., New York, New York.
- B. Phipps, Lloyd J., Mechanics in Agriculture, Interstate Printers and Publishers, Danville, Illinois.
- C. Shinn, Glen C. and Curtis R. Weston, Working in Agricultural Mechanics., McGraw Hill, Inc., c. 1978.

REPAIRING AND SHARPENING TOOLS
TWIST DRILL

INFORMATION SHEET

I. Twist drill definition

- A. Twist drill is an end cutting tool having cutting edges sharpened to form angles with the axis of the drill. Twist drills are used to cut circular holes. The cutting angles are varied depending on the material to be cut (wood, soft metal, hard metal). Spiral grooves are formed in the drill bit to remove the metal cuttings. Twist drills are made of carbon tool steel or high speed steel.

II. Parts of the twist drill (Transparency 1)

- A. The drill has three general parts - the shank, the body, and the point
- B. Shanks - the portion held by the drill chuck
 - 1. Straight shank
 - 2. Taper shank
 - 3. Blacksmiths shank
 - 4. Bit stock shank
- C. The body consists of the following parts:
 - 1. Flutes - grooves which remove cuttings
 - 2. Margin - area left after under cutting of body - reducing frictional contact
 - 3. Body clearance - the under cut area between margins and flutes
 - 4. Web - the thin partition in the center of the drill - between flutes
- D. The point - the entire cone shaped end of the drill which forms the cutting end. It contains the following parts:
 - 1. Dead center - the chisel shaped portion of the point - usually forms a 135° angle with a cutting lip
 - 2. Lip - (cutting edges), formed by intersection of the flute and cone-shaped point, must be of equal length and angle
 - 3. Lip clearance - is the amount of relief ground on the point extending back from the cutting edge to the heel

III. Degree of angle (Transparency 2)

(NOTE: The following angles are normal for a general purpose metal cutting twist drill.)

- A. Included angle - 118° , ($59^{\circ} + 59^{\circ}$)
- B. Lip clearance angle - $12^{\circ} - 15^{\circ}$
- C. Dead center angle - 135°

(NOTE: As material hardness increases the included angle would be increased to as much as 150° . For softer material such as wood it could be reduced to as little as 90° .)

IV. Reason for using cutting oil

- A. Reduce frictional drag
- B. Carry away heat
- C. Carry away cuttings
- D. Improve finish
- E. Allow faster cutting speed

V. Four classifications of cutting oils

- A. Pure lard oil
- B. Mineral lard oil
- C. Pure mineral oil
- D. Soluble cutting compounds

VI. Suggested cutting oil application

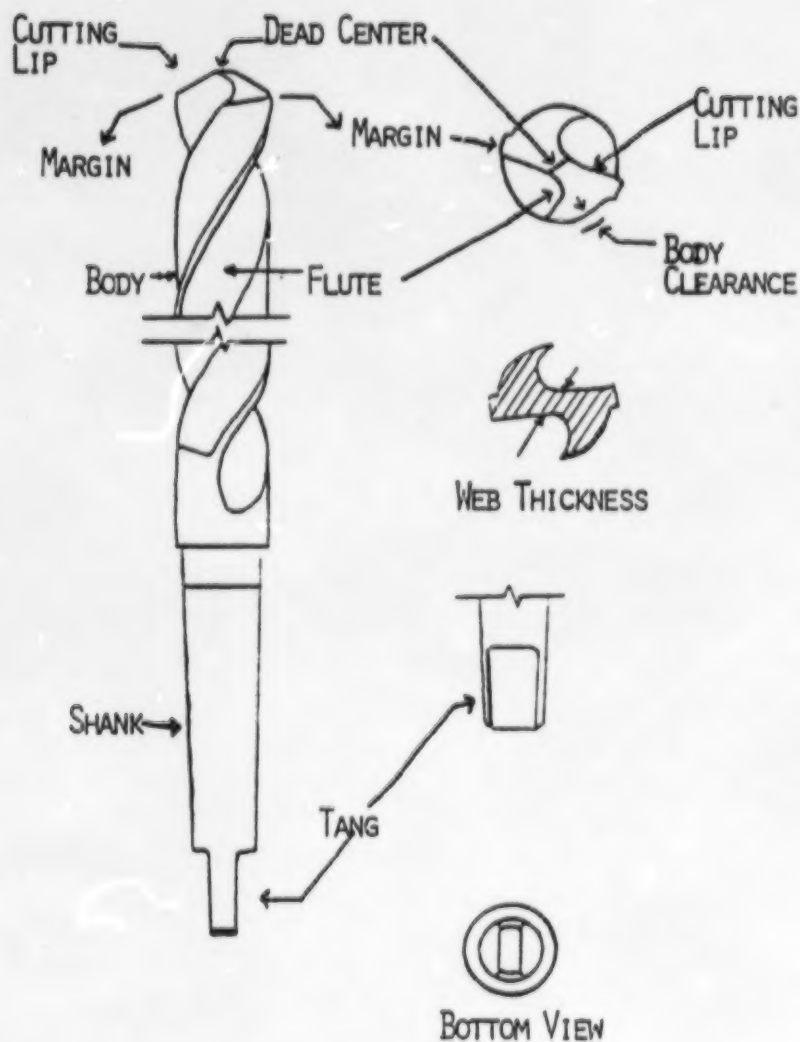
- A. Steel and iron - mineral lard oil
- B. Aluminum - kerosene
- C. Cast iron and brass - dry

VII. Size designations for drill bits - four systems

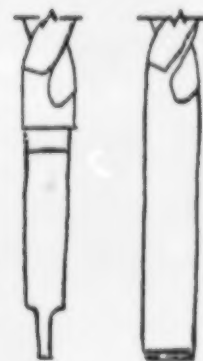
- A. Fractional - $1/64"$ to $3"$ by steps of $1/64"$
- B. Numbers - #1 to #80 - ($.228"$ to $.0135"$)
- C. Letters - A to Z - ($.234"$ to $.413"$)
- D. Metric - 0.4mm - 50mm
- E. Sizes are usually stamped on drill shank
- F. Size can be measured across margins

THE TWIST DRILL BIT

PARTS OF A TWIST DRILL



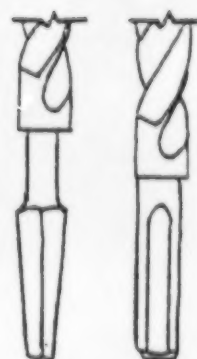
SHAPES OF TWIST DRILL SHANKS



TAPER SHANK



STRAIGHT SHANK

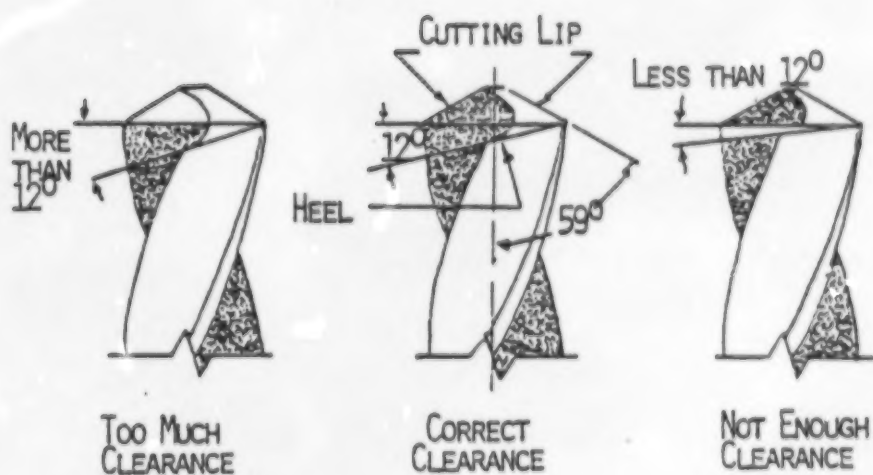
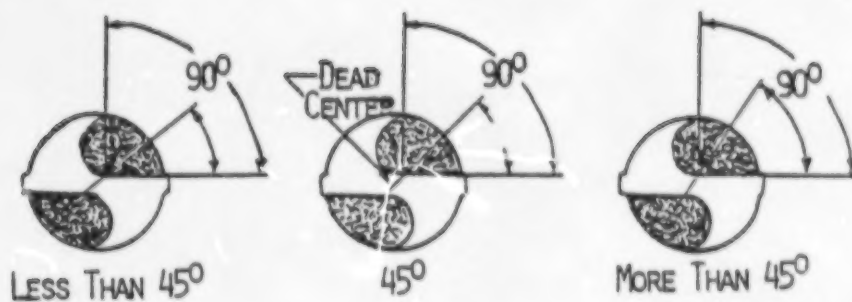


BIT STOCK SHANK



BLACKSMITH SHANK

ANGLES ON THE TWIST DRILL BIT



REPAIRING AND SHARPENING TOOLS
TWIST DRILL

JOB SHEET #1 - SHARPENING THE TWIST DRILL BIT

I. Tool and equipment needed

- A. Bench grinder with fine grit stone
- B. Goggles or face shield
- C. Dull twist drill bit
- D. Twist drill guage
- E. Pan of water to cool bit

II. Procedure

- A. Grinding specifications - Included Angle - 118°
Dead center angle - 135°
Lip clearance angle - 12°
- B. Hold the drill near the point with the left forefinger and thumb. Cradle the drill in the first joint of the forefinger and place the back of the finger on the tool rest. (See figure 1 and 3)
- C. Grasp the drill shank in the right hand with the thumb on top move the point forward until one lip comes in contact with the grinding wheel. At the beginning of each stroke, be sure that cutting lip is straight across the face of the wheel. The axis of the bit should form a 59° angle with the face of the grinding wheel. (See figure 1)
- D. When the drill comes in contact with the wheel, push the drill shank downward to the left and at the same time, rotate the drill about $1/16$ of a turn to the right. (Move to the left approximately 12° during each stroke.)
- E. Keep the lip length equal by grinding one and then the other, alternately. Use the guage to frequently check lip length and angle. (See Figures 2 and 3)
(NOTE: Grinding the shorter lip will lengthen it and at the same time sharpen the longer side.)
- F. Check lip clearance by placing the cutting edge against the angle portion of the guage; then rotate to the heel portion; the amount of gap indicates the amount of lip clearance.
 - $1/4$ " drill should have $1/32$ " gap
 - $3/4$ " drill should have $3/32$ " gap
 - $1/2$ " drill should have $1/16$ " gap
 - 1" drill should have $1/8$ " gap

Positioning Twist Drill to Sharpen



FIGURE 1

A--Checking the shape of the point of a twist drill, B--Checking the clearance.

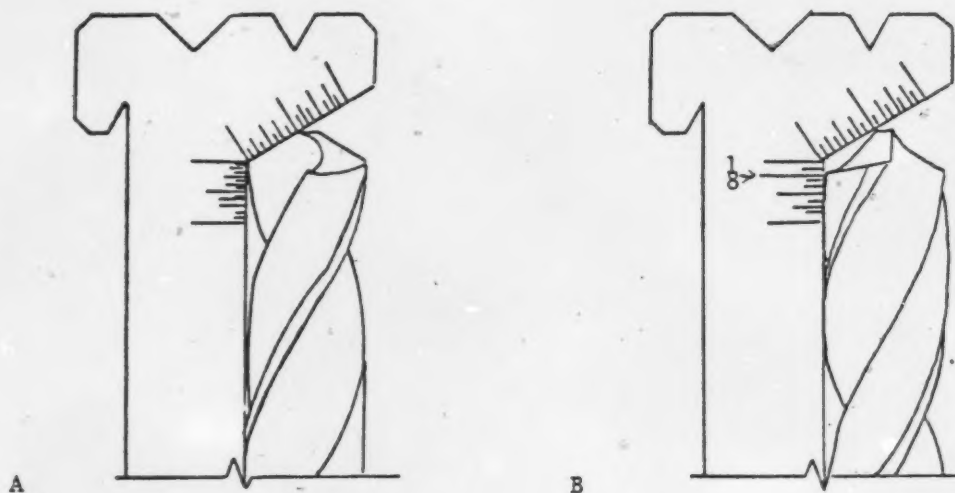
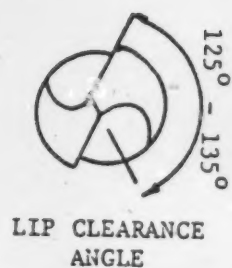
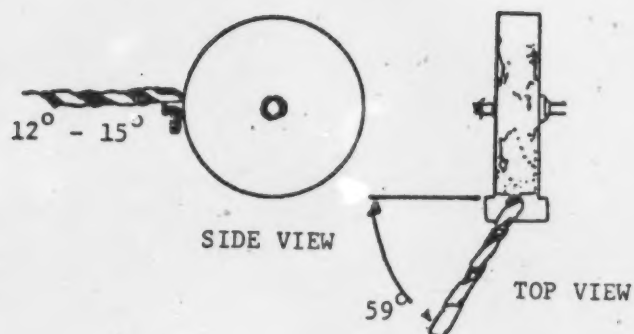
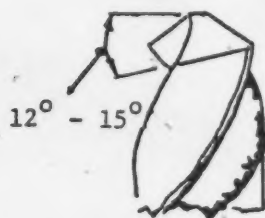


FIGURE 2

FIGURE 3



CHECK LENGTH
ANGLE, AND
CENTER OF POINT



$12^{\circ} - 15^{\circ}$ CORRECT
CUTTING EDGE
CLEARANCE

BY EYE



BY GAGE

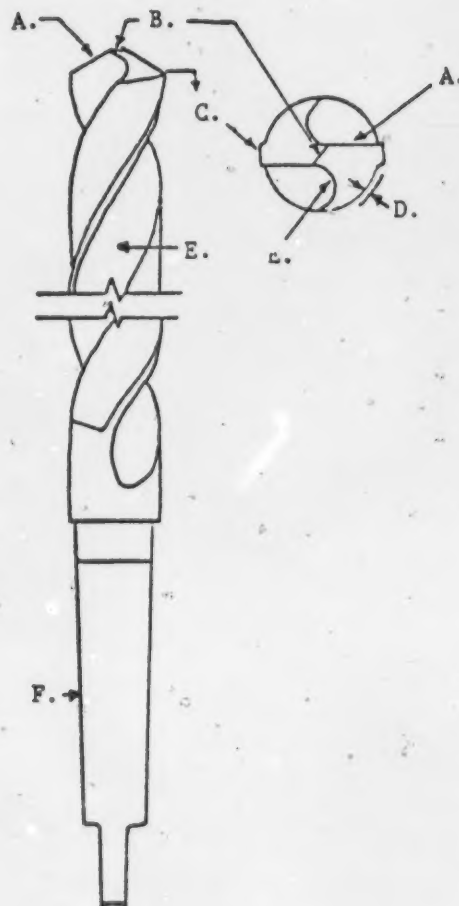
REPAIRING AND SHARPENING TOOLS
TWIST DRILL

TEST

1. Define twist drill.

2. Identify the indicated parts on the twist drill.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____



3. Match the degree of angle to the desired part.

- | | |
|-------------------------|------------|
| _____ a. Included angle | (1) 135° |
| _____ b. Lip clearance | (2) 118° |
| _____ c. Dead center | (3) 12-15° |

4. List four reasons for using cutting oil.

- a.
- b.
- c.
- d.

5. Name four classifications of cutting oils.

- a.
- b.
- c.
- d.

6. Match the job to the desired cutting oil.

- | | |
|------------------------------|-------------------------------|
| _____ a. Mild steel drilling | (1) Kerosene |
| _____ b. Aluminum drilling | (2) Dry |
| _____ c. Cast iron drilling | (3) Soluble cutting compounds |

7. Name the four systems of twist drill size designation.

- a.
- b.
- c.
- d.

8. Demonstrate the ability to sharpen a twist drill.

REPAIRING AND SHARPENING TOOLS
TWIST DRILL

ANSWERS TO TEST

1. Twist drill is an end cutting tool having cutting edges sharpened to form angles with the axis of the drill. Twist drills are used to cut circular holes. The cutting angles are varied depending on the material to be cut (wood, soft metal, hard metal). Spiral grooves are formed in the drill bit to remove the metal cuttings. Twist drills are made of carbon tool steel or high speed steel.
2.
 - a. Cutting lip
 - b. Dead center
 - c. Margin
 - d. Body clearance
 - e. Flute
 - f. Shank
3.
 - a. (2)
 - b. (3)
 - c. (1)
4. Any four of the following:
 - a. Reduce frictional drag
 - b. Carry away heat
 - c. Carry away cuttings
 - d. Improve finish
 - e. Allow faster cutting speed
5.
 - a. Pure lard oil
 - b. Mineral lard oil
 - c. Pure mineral oil
 - d. Soluble cutting compounds
6.
 - a. (3)
 - b. (1)
 - c. (2)

7.
 - a. Fractional - $1/64$ " to 3" by steps of $1/64$ "
 - b. Numbers - #1 to #80 - (.228" to .0135")
 - c. Letters - A to Z - (.234" to .413")
 - d. Metric - 0.4mm - 50mm
8. Evaluated to the supervisors satisfacton.